(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 January 2003 (23.01.2003)

PCT

(10) International Publication Number
WO 03/007350 A2

(51) International Patent Classification[7]: H01L 21/00

(21) International Application Number: PCT/US02/22469

(22) International Filing Date: 11 July 2002 (11.07.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/304,904 12 July 2001 (12.07.2001) US

(71) Applicant: SPEEDLINE MANUFACTURING COMPANY [US/US]; 1820 Springvalley Drive, Springfield, PA 19064 (US).

(71) Applicants and
(72) Inventors: LINKER, Frank, V, II [US/US]; 1820 Springvalley Drive, Springfield, PA 19064 (US). LINKER, Frank, V, Jr. [US/US]; 242 Sussex Boulevard, Broomall, PA 19008 (US).

(74) Agent: RENZ, Eugene, E., Jr.; Eugene E. Renz, Jr., P.C., 205 North Monroe Street, P.O. Box 2056, Media, PA 19063-9056 (US).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *without international search report and to be republished upon receipt of that report*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

WO 03/007350 A2

# (54) Title: WAFER JAR LOADER METHOD, SYSTEM AND APPARATUS

(57) Abstract: A method for packaging wafers having a bottom side and a top circuit side in jars comprising the steps of placing a cassette having a plurality of pockets for wafers at the back side facing upwardly, transferring the top wafer in the cassette by means of a vacuum suction mechanism which centers the top wafer in the cassette pocket upon initial engagement and than transfers and discharges the wafer in a jar located at a jar station and feeding interleafs in timed relation to the wafer feed so that an interleaf is positioned between each wafer loaded in a jar.

# WAFER JAR LOADER METHOD, SYSTEM AND APPARATUS

## FIELD OF THE INVENTION

This application claims the benefit of U.S. Provisional Application No. 60/304,904 filed July 12, 2001.

The present invention relates to a method and apparatus for loading wafers used in the manufacture of integrated circuits into shipping containers, commonly called jars.

## BACKGROUND OF THE INVENTION

These wafers are very fragile and expensive, some wafers being valued in the order of $10,000.00 and accordingly, equipment of the type to which the present invention relates must be capable of handling the wafers very carefully to minimize damage. In accordance with some prior art systems, the wafer holder cassette is placed in the loader with the circuit side of the wafer facing upwardly and then removed from the pockets in the cassette by apparatus which engages under a wafer in the cassette to withdraw it and then rotates the wafer so that the bottom faces upwardly before it is discharged into the wafer jar container. Paper liners are interleaved between the wafers stacked in the wafer jar container by mechanism including a suction cup or vacuum system which limits the type of interleaf material that can be used and eliminates some form of economic porous papers which would serve the purpose adequately from separating the wafers in the wafer jar container.

## SUMMARY OF THE INVENTION

With the foregoing in mind, it is an object of the present invention to provide a system and apparatus for automatically removing wafers from cassettes and safely loading them into shipping jars wherein characterized by novel features of construction and arrangement providing a system which transfers the wafers quickly and safely virtually eliminating counting errors and mishandling of wafers.

In the system of the present invention the cassettes are mounted at a loading station with the H-bar facing up which orientation presents the bottom non-circuit side of the wafers and thus eliminating the need to rotate wafers in the transfer process. Accordingly, wafers are picked up from the back side and therefore jar loading is smoother and faster and the risk of mishandling of wafers is further reduced.

More specifically, the wafer transfer mechanism of the present invention utilizes a vacuum pick and place arm mechanism with a vacuum generator built in integrally to provide a linear transfer, which is smooth and vibration free one wherein the wafers are levitated in the initial transfer cycle so that they do not engage the ribs defining the wafer pockets in the cassette and wherein the wafer is released and gently guided into the jar to ensure safe, accurate, even placement.

The wafer jar container is positioned on a shelf at the wafer loading station that is easily retractable for easy access and incorporates mounting guides which ensure proper jar positioning. The configuration is such that it accommodates all popular styles of jar containers.

Another feature of the system and apparatus of the present invention is the particular configuration and arrangement of the interleaf loading chamber and interleaf chute and the means for storing and discharging one interleaf at a time in timed relation with the wafer transfer mechanism so that interleaves are positioned quickly and accurately in the jar container between all of the wafers during a loading cycle. The pull out chamber holds up to 500 interleaves and the system is designed to accommodate either porous or non-porous interleaves which are carbon based. As explained in detail, hereinafter, the system is set up for maintaining automatic pressure on the stack of interleaves and includes a low paper sensor signal which signals the operator when reloading is required. The interleaf chute assembly is characterized by novel features of construction and arrangement whereby interleaves are fed into the chute until a wafer is in a jar and when the interleaf is released, advanced interleaf placement technology insures accurate, gentle insertion of the interleaves into the jar.

Summarizing the features of the **Wafer Jar loader System and Apparatus** of the present invention, the system has a high capacity and is capable of loading 10 wafers per minute, it accommodates all styles of commonly used jar containers up to 3 1/8 inch deep, accepts all popular styles of wafer holder cassettes and runs porous tyvek or non carbon based interleaves.

The apparatus is rather simple and compact in design and presents a clear operator view to the wafer transfer process by reason of a see-through plexidome housing which protects the wafers without obscuring visibility. The main controls of the system are easy to access and the short cassette to jar distance maximizes through put and minimizes the chances of mishandling and damage to wafers.

## BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects of the present invention and the various features and details of the operation and construction thereof are hereinafter more fully set forth with reference to the accompanying drawings, wherein;

FIG. 1 is a plan top view of the Wafer Jar Loading system showing the functional stations and operating elements;

FIG. 2 is a sectional view taken along line A-A of FIG. 1 showing details of the Wafer Jar Loading system;

FIG. 3 is a side and top plan view of an inverted cassette showing the H-Bar upward and used as a datum for registering the cassette and wafers;

FIG. 4 is a schematic which illustrates of the sequence and order of a typical wafer jar container loading process. Major elements of the loading process are shown removed from the system for clarity of operation. The sequence is automatically continued until all wafers are loaded into a shipping container jar. The operator then reloads wafers, container jar, and interleaf material to start another loading process;

FIG. 5A is a side view of a cassette;

FIG. 5B is a side view of a cassette holder;

FIG. 6A is a side elevation view of a cassette installed in a cassette holder with lever and cam mechanism in an unseated position;

FIG. 6B is a side elevation view of a cassette installed in a cassette holder with lever and cam mechanism in a seated position;

FIG. 7A is a detail of holder switch indicating that cassette in an unseated

position;

FIG. 7B is a detail of holder switch indicating that cassette is in the seated position;

FIG. 8 is a side elevation view partly in section showing the spring biasing means

for normally biasing the wafer locating plate in operative limit position;

FIG. 9 is a top plan view with parts broken away of the cassette and the wafer seating assembly into limit positions;

FIG. 10 is a top plan view of the transfer pickup station showing extreme limit positions for the suction pickup;

FIG. 11 is a transverse sectional view taken of lines 11-11 of FIG. 10;

FIG. 12 is a side elevational view of the suction pickup and wafer cassette prior to activation of the suction cup to engage the uppermost wafer in the cassette;

FIG. 13 is a view similar to FIG. 12 showing the details of the vacuum transfer mechanism;

FIG. 14 is an enlarged transverse sectional view through the shipping container or jar;

FIG. 15 is a fragmentary view showing the suction pickup engaging the uppermost wafer;

FIG. 16 is a fragmentary view showing the gap sensor and flag which determines the engaging stroke of the suction pickup;

FIG. 17 is a fragmentary view showing automatic centering of the uppermost wafer when vacuum is applied to the cup;

FIG.'s 18, 19, 20 are transverse sectional views of another embodiment of suction vacuum pickup device in accordance with the present invention;

FIG. 21 is a view showing the cup mounted on the section pickup arm;

FIG. 22 is a fragmentary sectional view showing the suction pickup showing the second embodiment of a suction pickup engaging the uppermost wafer in the cassette;

FIG. 23 is a fragmentary view showing the centering function;

FIG. 24 is a view of the control panel;

FIG. 25 is a perspective view of a wafer non-inverted cassette;(inverted cassette)

FIG. 26 is a fragmentary perspective view showing some of the details of the interleaf station;

FIG. 27 is a perspective interleaf station showing the interleaf storage container;

FIG. 28 a plan view of the interleaf station;

FIG. 29 is a fragmentary section taken on lines 29-29 of FIG. 28 showing a slide drawer;

FIG. 30 is a sectional view taken on lines 30B-30B of FIG. 30A;

FIG.30A is a transverse sectional view showing the interleaf loading mechanism;

FIG. 31 show the switches for the cam nut design featured in FIG. 30;

FIG. 32 is a bottom plan view of the pulley for activating the leafs through on the interleaf lift mechanism;

FIG. 33 is an enlarged sectional view showing the interleaf stack and wheel runner;

FIG. 34 is a fragmentary sectional view similar to FIG. 33 showing the wheel runner in its initial retract position to condition the uppermost interleaf for discharge from the stack;

FIG. 35 is a perspective view of the portion of the interleaf mechanism for taken on lines G-G of FIG. 34;

FIG. 36 is a fragmentary view showing the wheel runner advancing the uppermost interleaf to positioned where it can be discharged down the chute to the jar;

FIG. 37 is a perspective view showing the interleaf in position to be discharged to the jar; and

FIG. 38 is a view showing the interleaf discharging into the jar.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to Figures 1 and 2, there is shown a top plan view and a side section view respectively of a system and apparatus 10 for packaging wafers W in shipping containers J. The system 10 is shown removed form its housing and comprises a cassette loading station 14, a transfer pickup station 16, for removing wafers W from cassettes C, a shipping container station 18 with pull out shelf 21 to position containers for loading, a slide drawer interleaf station 22, and an operator control station that initiates the automatic sequencing of alternately placing wafers W and interleafs I into shipping containers J as well as controlling and monitoring all other functions.

In Figure 2 three cassette loading positions are shown; an initial load position 26, a wafer number 1, load position 28, and a wafer number 25, load position 30. As wafers W are transferred to the shipping container J, the cassette C is incrementally raised by cassette lift mechanism. Wafers W are transferred from cassette C to shipping container J as the pickup arm 34 with pickup cup 36 traverses distance 38 along a horizontal track 40 depositing wafers W in a shipping container J. Figure 1 shows a shipping container J on pull out shelf 21 in two positions; with the pull out shelf extended as at $21^a$ and seated as at $21^b$. The shipping container J generally contains a foam ring 42 around the internal periphery and a foam bottom pad 44 to cushion and protect wafers W. Pull out shelf 21 sits on positioning mechanism 46 that rides along two horizontal tracks 48. Interleaf slide drawer is shown with cover 52 raised

and is comprised of a slide drawer 54 for a supply of interleafs I, an interleaf feed wheel 56 and peel blade 58, an interleaf lift mechanism 60, and an interleaf chute 62. Slide drawer 54 is shown in an open position $54^a$ and seated position $54^b$.

Considering the system and apparatus in terms of function and referring to Figures 1 and 2, wafers W housed in a conventional cassette C are transferred one at a time from the cassette C to the shipping container J. In accordance with the present invention, the cassette C is positioned so that the wafer's circuit sides are down facilitating easy and rapid transfer of wafers W from the cassette C to the shipping container J without the need for expensive and complicated robotics to rotate wafers. To facilitate understanding of the following embodiment, a schematic representation of the container loading sequence is shown in Figures 4, 10 and 11. Figure 4 shows a wafer cassette C having a transport handle, a so-called H-Bar 64 which also provides the loading surface datum 66. A typical shipping container J with foam pad ring 42 and foam pad disc 44 is inserted to protect wafers W during loading and shipping. As illustrated, container loading is achieved in a predetermined sequence. A disc-like interleaf I is first inserted (interleaf No. 1) followed by a wafer W (wafer No.1). This sequence and order repeats until the desired number (N) of wafers W have been placed in container J. When wafer w (No. N) is placed into container J one more interleaf I (No. N+1) is placed into container J. The container J is removed and foam filler pads 68 are placed inside container J to fill remaining space above wafer W (No. N) before installing container lid.

Wafers W have two flat surfaces with one being the back and the other being the circuit side. The nominal wafer orientation in cassettes C is with the backside facing toward the bottom and the circuit side facing up. However, packaging in containers J require the circuit side facing down towards the container bottom. With the backside facing upwardly unpacking wafers W is easier and more rapid since only the back surface can be handled leaving the circuit side untouched. Unique to the present invention is the upside down and inverted positioning of the cassette C, eliminating the need to flip the wafer upside down for placement into the container J. This simplifies the automation process, speeds the loading and more importantly reduces handling.

The cassette loading station 14 is comprised of a wafer cassette C illustrated in Figure 1 and 2, a cassette holder 82 shown in Figure 5A, 5B, 6A, and 6B, and a cassette lift mechanism. The wafer cassette C is of conventional design and typically made of a plastic material and has a pair of sidewalls 72 and 74 and a series of ribs 26 which define pockets 78 for the wafers W. A clearance between wafers W (see fig. 3) and the pockets 78 allow wafers W to be removed from the pockets 78 without damage. The cassette C is positioned so that the H-Bar 64 is facing up thereby locating surface datum 66 in an upward position with the transport handle 80 in a downward position.

Cassette holder comprises a housing 82 having sides 84 and 86, and a base 88. Base 88 has a pair of runners 90 and 92 (FIG's 7A and 7B) which complement the bottom shape of cassette C so that cassette C can slide in place in a longitudinal direction into cassette holder. Cassette C has a so called H-Bar

64 which aligns with the top plate 94 of cassette holder. When cassette C is locked in place , H-Bar 64 engages switch 96 (FIG's 6A, 6B) to condition the apparatus and system 10 for transferring wafers W into shipping container J in a manner described hereafter.

A wafer-seating plate 100 having a curved front face 102 complementing the curvature of wafers W is engaged by wafers W when the cassette C is positioned in place in the cassette holder. The function of the wafer-seating plate 100 is to ensure that all of wafers W are fully seated in cassette pockets 78 so that the pickup arm 34 engages the back side surface of each wafer 12 in the same relative position thereby properly aligning the wafers W when they are transferred to the shipping container J.

When the cassette C is in place in the manner described above, the handle 83 is rotated from its horizontal rest position as shown in Figure 6A to the position shown in Figure 6B. Through a linkage 104 and cam 106 arrangement, the wafer-seating plate 100 moves forwardly so that there is a predetermined clearance between the front face of seating plate 100 and wafer W to permit transfer of wafers W in a manner to be described. As shown in Figure 6A, the wafer-seating plate 100 is normally biased to a forward limit position (cam position A, FIG. 8) by a pair of compression springs 108. A slide bearing 110 supports the wafer-seating plate 100 so that it moves in a truly horizontal plane and does not cock during activation between cam position A and cam position B thereby seating all of wafers W in a uniform fashion. The actuation of the handle 83 raises cassette C so that the H-Bar 64 engages and locks in place with the

top plate 94 of cassette holder 82. When cassette C is fully locked in place, switch 96 conditions the system for operation and feed and transfer of wafers W from the cassette C to the transfer station 16. The clearance between the wafers W and the wafer-seating plate 100 ensures incremental vertical displacement of the cassette C during the transfer cycle in a manner to be described in more detail hereafter.

Figure 8 illustrate the wafer-seating plate 100 when the cassette C is loaded and when the lift handle 88 is rotated. Figure 9 is a cut-away to show a top view of the cam linkage 104. The wafer-seating plate 100 is split along the center showing the portion with respect to the wafer W and cassette C with cam 106 in position A and B. When at position B, the cassette C is raised and the H-Bar 64 is deflected as shown in Figure 9. Figure 8 illustrates the linear motion achieved upon moving cam 106 from position A to B and details the opposing linear compression spring 108 stroke limit screw 112 and linear slide bearing 110 arrangement.

Consider now the pick up transfer station 16 of Figures 1 and 2 and with reference to Figures 10, 11 and 12. When switch 96 in cassette holder 82 is activated by H-Bar 64 verifying that cassette C has been loaded in correct orientation, pick up arm 34 is enabled for automatically transferring wafers W from cassette C to shipping container station 18. Figure 11 is a side cutaway view wherein the pickup arm 34 transfers wafer W to wafer release position 134. Figures 11 and 12, are side and front elevation views of transfer pickup arm assembly 34 and cassette C. The portion of cassette holder 70 that secures and

registers the H-Bar 64 has been hidden from this figure for explanation of the wafer pickup sequence. The pickup/transfer arm assembly 34 consists of a vacuum cup 136, slide arm 138, slide base140, gap sensor142, interrupt flag 144, counterbalance extension springs 146, and two-screw stops 148. The slide arm 138 is shown in a starting position where the slide arm 138 is downward and arrested on two-screw heads 148 and stop surfaces 148. The two counter balance springs 146 add resistance in the opposite direction to reduce the effective weight of the slide arm assembly 140 that will contact the wafer W. Figure 12 best illustrates the gap sensor 142 and interrupt flag 144 relationship with the slide arm 140 in the starting position. The distance between the sensor 142 and the flag 144 allow for detection of contact with the wafer W. The amount of slide arm 138 movement can be varied by adjusting the distance away from the sensing point. For compliant type vacuum cups 136, this distance allows the cup to collapse without pulling the wafer W upward against the cassette C top side support grooves. As illustrated in Figure 15, the vacuum cup 136 illustration identifies "cup support ribs" 150. These ribs150 are stops within the vacuum cup 136 which limit the amount of compliance on vacuum cup136 when vacuum is drawn. Figure 15 shows the vacuum cup 136 making initial contact with the wafer W. The wafer 12 continues being raised until the flag 144 interrupts the sensor 142 within the gap distance shown in Figure 15. Once the sensor 142 is blocked, cassette C motion is stopped and vacuum is turned on to the vacuum cup 136. As vacuum builds up, the cup 136 begins to collapse. This collapsing motion allows the slide arm 58 to move downward until the stop

surfaces 148 are engaged by the screw head 152. Then the balance springs 146 lift the wafer W off the bottom side guides as shown in Figure 16. The last motion is when the cassette C is lowered a programmed amount to center the wafer within the cassette support slots and the wafer is pulled out.

Consider now a typical cycle of operation with the parts in the position shown in Figs 10 and 11. The pickup transfer arm 34 is moved from a position overlying the container J to the wafer W and then the cassette C is raised so that the top wafer W engages the vacuum cup 136 and displaces the slide arm 58 a predetermined distance as determined by gap sensor 142. This initiates the vacuum which causes the vacuum cup 136 to flatten and tend to displace a wafer W upwardly a predetermined small distance. However, the slide arm 58 can return to its home position and in this position, the wafer W is centered in its pocket 32 to avoid any biasing in the grooves of the cassette C which may damage the wafer W. When all of the wafers W in a given cassette C have been transferred from the cassette C to jar or container J, the control panel then signals the operator to replace the empty cassette C with another full one. The system 10 can be set to transfer selected numbers of wafers W for an automatic cycle of operation.

Consider now briefly part of an operational cycle and assume that the pickup arm overlies the wafer W and the system is ready to initiate a transfer cycle. In position 132 of pickup arm 34, a cassette drive motor elevates the cassette holder 82 and when the top wafer W engages the suction cup 136, the sensor flag 144 activates the gap sensor 142 which signals the cassette motor to

stop. Simultaneously, the vacuum cycle is activated. The vacuum causes the suction cup 136 to comply. The arrangement just described including the flag 144 sensor 142 and limited range of travel of a slide arm 138 in slide base 140 ensures that wafers W are not damaged or are biased in the cassette pockets 78 during a transfer cycle. The pickup assembly further includes counter-balancing springs 180 extending from a projection on slide base 140 to the slide arm 138 as shown in Figure 12. This arrangement minimizes load on the wafers W and on the suction cup 136 when the cassette C is raised in the manner described above wherein the top wafer is engaged initially by the suction cup 136 again in the manner described above.

Considering now the Interleaf station 22, and referring to Figures 26 and 27, perspective views of the Interleaf feed mechanism are shown. Disc-like interleafs I made of a tissue paper product are stacked in Interleaf holder 240 (shown in an op load position), automatically released and interspersed one at a time between wafers(W). In Figure 26, the Interleaf cover 241 is shown in an open position exposing the paper buckle and release mechanism 242, Interleaf queue and release station 243, air cushion chute 244, and Interleaf lift mechanism 245. Interleaf holder 240 is an elongated generally rectangular slide drawer 246 having an open bottom depending-cylindrical container 247. interleafs I are stacked on top of a vertically movable lifter pad 248 which is attached to the upper end of lifter adjustment screw 249 and projects into the open bottom of cylindrical container 247. Interleafs I are held in place in the cylindrical container 247 of Interleaf holder 240 by a semi-circular back edge

retainer 250 of Figure 28 which projects slightly beyond the opening of cylindrical container 247 to engage an annular portion of the top Interleaf I. A peel blade 251 having an entrance and exit ramps 252 and 253 respectively extends over the Interleaf opening at approximately from the rim 254 to hold the interleafs I in place in the manner shown in Figure 28.

When the slide drawer 246 is seated, as shown in Figure 28, Slide drawer front edge 255 depresses switch 256 and ball plunger 257 extends in slide drawer detent grooves 258 seating slide drawer 2, and preparing the system 10 for sequential operation.

With slide drawer 246 in place, the feed sequence begins with the Interleaf lift mechanism 245 raising the interleafs I up to peel blade 251 and back edge retainer 250 applying a constant but controlled force as shown in Figure 33. The distance between pre-load springs 259 and upper support angle 260 and lower support angle 261 achieve this constant force as shown in Figure 33. Both support angles 260 and 261 are attached to two linear rail bearing slide blocks 262 and 263.Both upper support angle 260 and lower support angle 261 and bearing blocks 262 and 263 have the pre-load gap/distance maintained by threaded rod and pre-load adjustment nut 265. The threaded rod'264 is attached to a threaded spring post 266 and locked with nut 267. The opposite end passes through a clearance hole in spring post 268 and through lower support angle 261. The pre-load adjustment 265 works against pre-load springs 259 to maintain a predetermined distance between upper support angle 260 and lower support angle 261. The pre-load adjustment nut 265 has a tapered surface which

makes contact with a pre-load sense switch that indicates nut 265 is seated against lower support angle 261.

During the Interleaf lift cycle, the force of the pre-load spring 265 will be exceeded causing upper support angle 260 and bearing block 263 to move toward opposing bearing block 262. This movement causes pre-load nut 265 to move away from lower angle 261. This small movement causes switch 269 to change state deactivating pre-load drive motor 270 which stops drive belt 271 and pulleys 272 This small is illustrated on Figure 31 wherein detail 'IC" shows switch 269 in a normally open condition on tapered surface of adjustment nut 265 which indicates no pre-load sensed and detail "D" shows switch 269 off taper of adjustment nut 265 in a normally closed condition which indicates a pre-load is sensed. Detail "D" also shows the gap 273 within which the pre-load switch 269 operates. Section E-E of Figure 32 is a bottom view of the pulleys 272 and drive belt 271 that drive lead screw 271A with attached lead screw nut 2713. Lifting of lifter pad 248 by lead screw 271A is achieved through the drive belt 271 and pulleys 272. Lead screw 271A is supported by two angular contact bearings 273 and retained through a mounting block 274 via a bearing take up nut 275. On activation of pre-load drive motor 270, lead screw 271A through drive belt 271 and pulleys 272 and motor 270 cause the nut 275 to move up/down depending on state of switch 269. Lower stroke limit sensor 276 and upper stroke limit sensor 277 control and limit the extent of Interleaf lift travel 278. Stroke limit sensors are triggered when the sensor flag 279 interrupts a light beam. This i illustrated in Figure 30A with the flag 279 shown 'at the lower stroke limit

position. Section E-E of Figure 32 shows a view of flag 279 passing through the sensor. During the upward cycle of raising and pre-loading interleafs, the pre-load switch 269 is activated and motor 270 stops until enough Interleaf sheets have been stripped from the stack to reactivate switch 269 and turn on motor 270. This sequence repeats until the upper stroke limit sensor 277 is blocked by flag 279. When this upper limit has been reached and switch 269 activates indicating no more pre-load is present, the motor is reversed until the sensor flag 279 returns to the starting lower limit stroke 276 position.

Considering now the interleaf station 22, and referring to Figures 26 and 27, perspective views of the interleaf feed mechanism are shown. Disc-like interleafs I made of a tissue paper product are stacked in interleaf holder 240 (shown in an open load position), automatically released and interspersed one at a time between wafers(W). In Figure 26, the interleaf cover 241 is shown in an open position exposing the paper buckle and release mechanism 242, interleaf queue and release station 243, air cushion chute 244, and interleaf lift mechanism 245. Interleaf holder 240 is an elongated generally rectangular slide drawer 246 having an open bottom depending cylindrical container 247. Interleafs I are stacked on top of a vertically movable lifter pad 248 which is attached to the upper end of lifter adjustment screw 249 and projects into the open bottom of cylindrical container 247. Interleafs I are held in place in the cylindrical container 247 of interleaf holder 240 by a semi-circular back edge retainer 250 of Figure 28 which projects slightly beyond the opening of cylindrical container 247 to engage an annular portion of the top interleaf I. A peel blade 251 having an entrance and exit ramps 252 and 253 respectively

extends over the interleaf opening at approximately from the rim 254 to hold the interleafs I in place in the manner shown in Figure 28.When the slide drawer 246 is seated, as shown in Figure 28, Slide drawer front edge 255 depresses switch 256 and ball plunger 257 extends in slide drawer detent grooves 258 seating slide drawer 246 and preparing the system 10 for sequential operation. With slide drawer 246 in place, the feed sequence begins with the interleaf lift mechanism 245 raising the interleafs I up to peel blade 251 and back edge retainer 250 applying a constant but controlled force as shown in Figure 33. The distance between pre-load springs 259 and upper support angle 260 and lower support angle 261 achieve this constant force as shown in Figure 33. Both support angles 260 and 261 are attached to two linear rail bearing slide blocks 262 and 263. Both upper support angle 260 and lower support angle 261 and bearing blocks 262 and 263 have the pre-load gap/distance maintained by threaded rod and pre-load adjustment nut 265. The threaded rod 264 is attached to a threaded spring post 266 and locked with nut 267. The opposite end passes through a clearance hole in spring post 268 and through lower support angle 261.

The pre-load adjustment nut 265 works against pre-load springs 259 to maintain a predetermined distance between upper support angle 260 and lower support angle 261. The pre-load adjustment nut 265 has a tapered surface which makes contact with a pre-load sense switch that indicates nut 265 is seated against lower support angle 261. During the interleaf lift cycle, the force of the pre-load spring 265 will be exceeded causing upper support angle 260 and bearing block 263 to move toward opposing bearing block 262. This movement causes pre-load

nut 265 to move away from lower angle 261. This small movement causes switch 269 to change state deactivating pre-load drive motor 270 which stops drive belt 271 and pulleys 272. This small is illustrated on Figure 31 wherein detail "C" shows switch 269 in a normally open condition on tapered surface of adjustment nut 265 which indicates no pre-load sensed and detail "D" shows switch 269 off taper of adjustment nut 265 in a normally closed condition which indicates a pre-load is sensed. Detail "D" also shows the gap 273 within which the pre-load switch 269 operates. Section E-E of Figure 32 is a bottom view of the pulleys 272 and drive belt 271 that drive lead screw 271A with attached lead screw nut 271B. Lifting of lifter pad 248 by lead screw 271A is achieved through the drive belt 271 and pulleys 272. Lead screw 271A is supported by two angular contact bearings 273 and retained through a mounting block 274 via a bearing take up nut 275. On activation of pre-load drive motor 270, lead screw 271A through drive belt 271 and pulleys 272 and motor 270 cause the nut 275 to move up/down depending on state of switch 269. Lower stroke limit sensor 276 and upper stroke limit sensor 277 control and limit the extent of interleaf lift travel 278.

Stroke limit sensors are triggered when the sensor flag 279 interrupts a light beam. This is illustrated in Figure 30A with the flag 279 shown at the lower stroke limit position. Section E-E of Figure 32 shows a view of flag 279 passing through the sensor. During the upward cycle of raising and pre-loading interleafs, the pre-load switch 269 is activated and motor 270 stops until enough interleaf sheets have been stripped from the stack to reactivate switch 269 and turn on motor 270. This sequence repeats until the upper stroke limit sensor 277 is blocked by flag 279.

When this upper limit has been reached and switch 269 activates indicating no more pre-load is present, the motor is reversed until the sensor flag 279 returns to the starting lower limit stroke 276 position.

Having positioned the interleaf stack for releasing single interleaf discs into the shipping container J, pre-load switch 269 activates pre-load drive motor 270 thereby causing lifter pad 248 to move upward through opening in the interleaf holder 240 to engage metal disc 280. The interleaf stack is forced against and stopped by the peel blade 251 and back edge retainer 250. Pre-load switch 269 now removes power from pre-load drive motor 270 readying interleafs for stripping one at a time while incremental pressure is maintained on the stack. Interleaf disc separation begins by activating separator motor 281 that drives the buckle/feed tire in a counter clockwise rotation pulling the front portion of the top interleaf to be pulled backwards from under peel blade 251 and causing the front portion of the top interleaf disc to bow or buckle upward 283 making contact with a light weight buckle paddle 284 pivoting it upward around its pivot point thereby activating sensor 285 mounted in housing 287 confirming interleaf has been released from under peel blade 251. Adjustment of sensor 285 can allow more or less buckling to occur. View G-G of Figure 35 is an isometric more clearly showing sensor 285 and buckle paddle 284. Having released the top interleaf from under peel blade 251, power to separator motor 281 is reversed causing buckle/feed tire to rotate clockwise pushing the interleaf forward and up over knife edge of peel blade 251 and under interleaf deflector 290 that guides the interleaf towards the queue and release station 292 and idler wheel 292A as shown in Figures 36 and 37. When the front edge of the

interleaf is detected by queue sensor 293 causing power to separator motor 281 to be turned off releasing the back portion of the interleaf so that the interleaf may continue its forward progress. Figure 37 illustrates the relationship.

The last part of the sequence is the release of the interleaf to the shipping container. First, a fan in fan enclosure 298 underneath the air chute 244 is turned on to provide an air cushion underneath the interleaf. The interleaf release/stage wheel 295 is reactivated releasing the interleaf and causing the interleaf to float down the inclined air cushion chute 244 surface toward a shipping container. The funnel ring 296 is tapered upward to form a funnel-like entrance to the shipping container to provide more clearance for the interleaf to enter. Three emitter/detector pairs 297 on the funnel ring form a light curtain sensing the passage of an interleaf. When any of the sensor pairs 297 detects an interleaf, the interleaf release/stage wheel 295 is turned off. These sensors 297 continue to be monitored until all sensors are unblocked indicating the interleaf has passed through into the shipping container. Figure 38 is a cutaway view taken along line G-G of Figure 37 showing the progress of an interleaf as it passes from the queue and release station 292 down air cushion chute 244 and into a shipping container. This sequence continues all interleafs are interspersed between wafers.

In a second embodiment, the vacuum pickup cup incorporates novel features of construction and arrangement to obviate potential non-alignment issues. The potential for both the wafer pickup surface and cup pickup surface being out of parallel is a normal condition. Though this parallel alignment error may not be large, it can be enough to prevent vacuum to be pulled. Referring now to Figure 18, the

pickup cup generally designated 310 consists of a threaded support post 311 which extends downwardly to the rigid pickup cup 312 where if flanges out as at 311A to form one side of an electrical contact 313. The flanged out section 311A has a hollow bore to allow a press fit of rigid cup 312. A port 314 through the center of support post 311 allows a vacuum to be pulled through rigid cup 312 and the small holes 315 that feed a pattern of circular grooves 316 which provide sufficient area to securely hold the wafer W during transport from the cassette C to the shipping containers J.

A floating cup ring 321 surrounds and slips over rigid cup 312 and has a recess in the upper surface of the flange to secure the upper contact 317. Lead wire 317A is soldered to contact 317 and terminates in and is attached with connector mount 317C a two-pin connector 317A and locked to threaded post 311 with lock nut 319. Upper contact 317, therefore, forms a normally closed switch. To prevent floating cup 321 from rotating and severing contact wire 317D, an anti-rotate pin 318 is provided eliminating rotation between parts. To assure anti-rotate pin 318 cannot dislodge, a plastic stroke limiter sleeve 320 is positioned above and returned via a press fit onto support post 311. The floating cup ring 321 has a periphery extending outer depending flange 316A which projects a predetermined distance D below a plane P-P through the bottom face 312A of cup ring when the cup ring 316 is fully seated as shown in Figure 18. Accordingly, when the vacuum assembly 310 is positioned to pick up a wafer W, the flange 316A first engages the wafer surface and is displaced relative to the cup 321. The contacts are opened to initiate activation of the vacuum.

## SUMMARY

Figure #1 below illustrates the three components processed on the Wafer Jar/Container Loader. The side view shows the typical Container loading process, where first a interleaf, #1, is placed into the new container and followed wafer #2 placed in the container. This sequence order repeats until the desired numbers of wafers have been placed in the container. Once this number has been loaded, one more interleaf will be placed into the container on top of the last wafer.
The container is removed from the machine and foam filler pads are placed inside to fill remaining space above wafers before installing the lid.

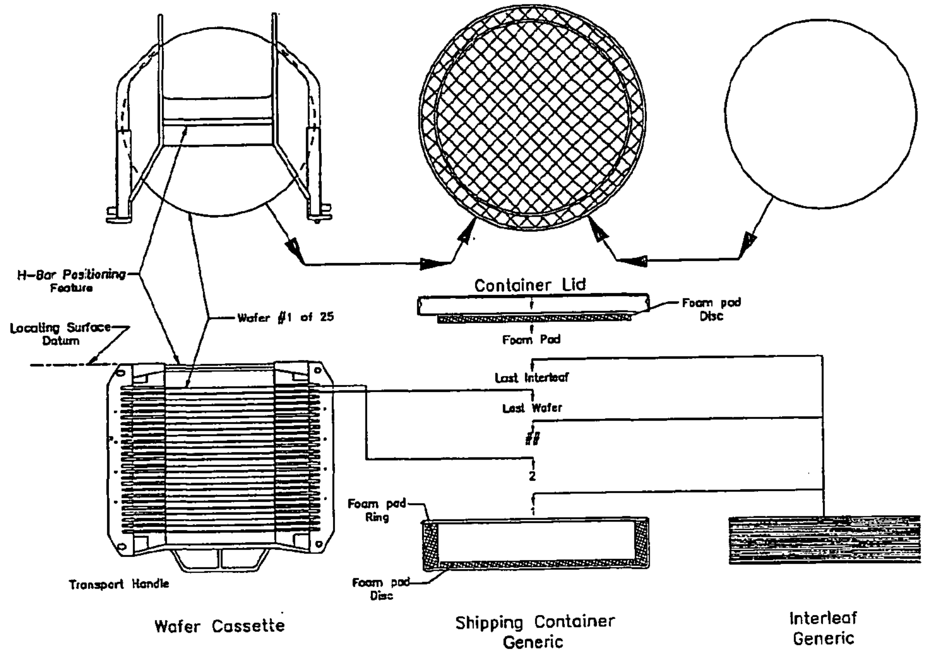



Fig $1^a$

The Cassette shown in figure $1^a$ is positioned so that the registration "H-Bar" feature is facing up.
Most all equipment processing from Wafer cassettes position the H-Bar down which is opposite to way shown above.
Wafers have two flat surfaces with one being the back and the other being the circuit side. The nominal wafer orientation in cassettes is with the backside towards the H-bar and circuitry facing away.
Loading containers requires the Circuit side be facing down towards the jar bottom.
This allows for easy unpacking having the backside facing up since only the back surface can be touched and cause no damage to the circuitry. Unique to this machine is the upside down and inverted positioning of the cassette, which eliminates otherwise the need to flip the wafer upside down for placement into the container. This simplifies the automation process, speeds the loading and more importantly reduces the handling.

The next Figure $2^a$, illustrates a plan top view of the machine with a cross sectional "A"-"A" view shown in figure $3^a$.

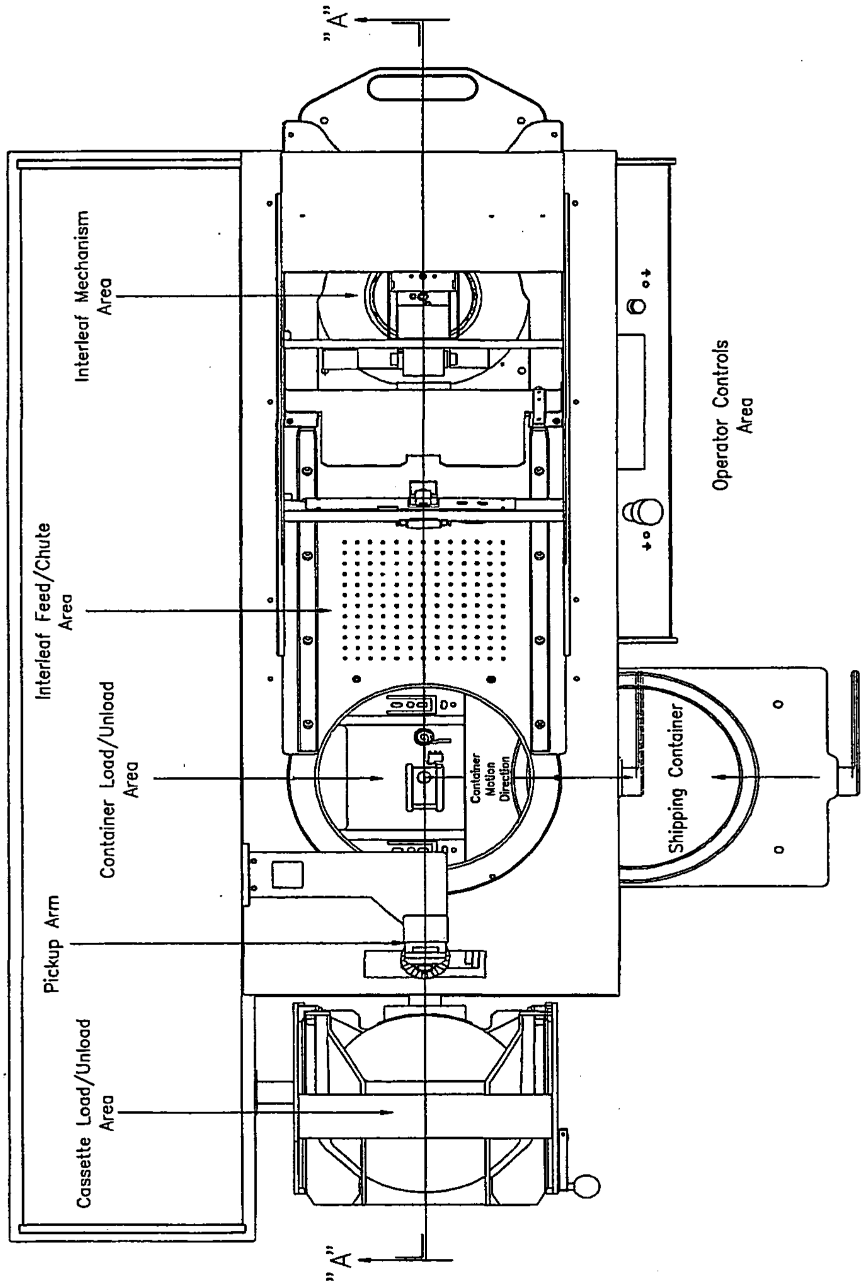

"A"
Interleaf Mechanism Area
Operator Controls Area
Interleaf Feed/Chute Area
Container Load/Unload Area
Container Motion Direction
Shipping Container
Pickup Arm
Cassette Load/Unload Area
"A"

Fig 2ª

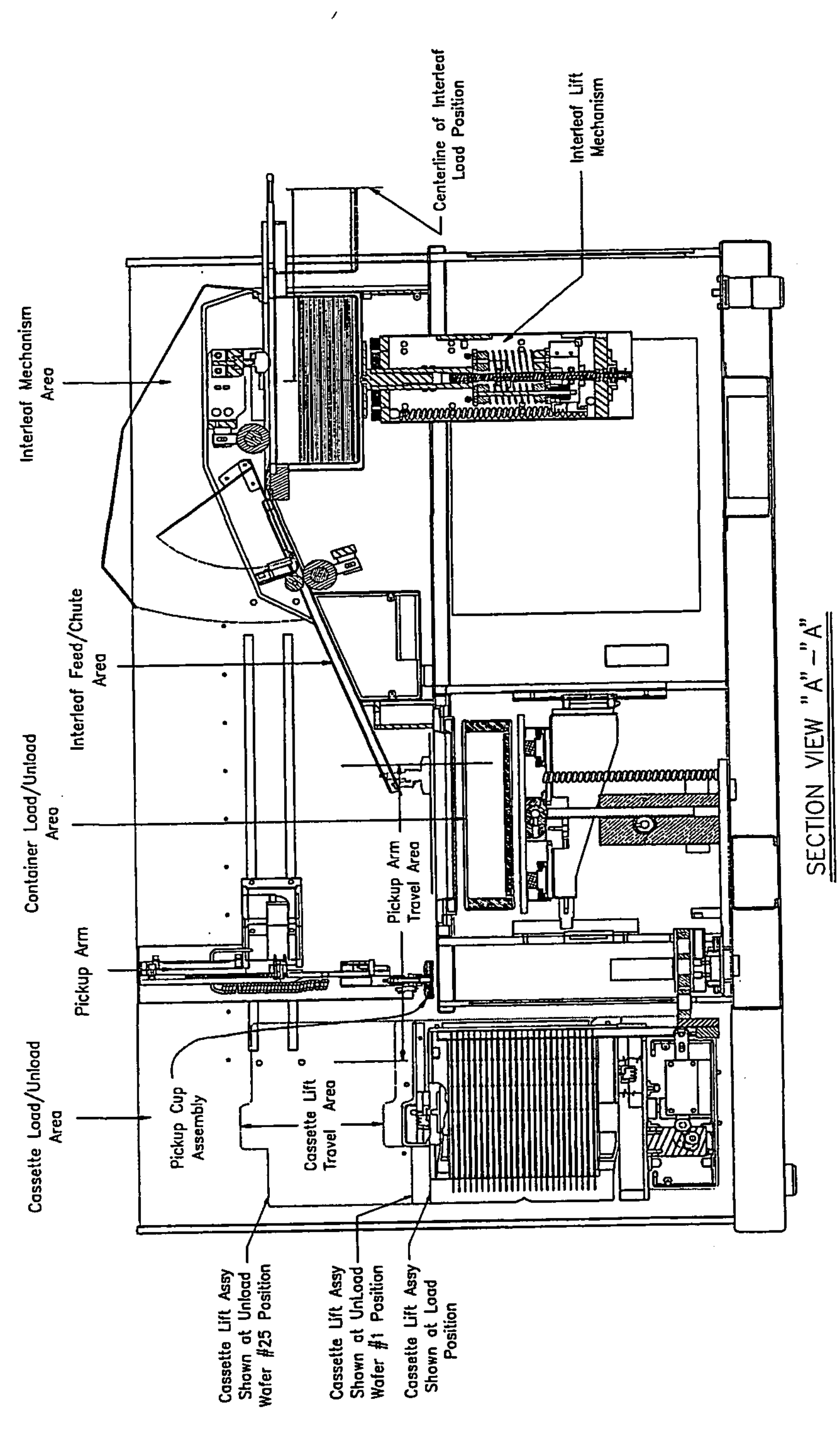

Centerline of Interleaf Load Position
Interleaf Lift Mechanism
Interleaf Mechanism Area
Interleaf Feed/Chute Area
Container Load/Unload Area
Pickup Arm
Pickup Arm Travel Area
Cassette Load/Unload Area
Pickup Cup Assembly
Cassette Lift Travel Area
Cassette Lift Assy Shown at Unload Wafer #25 Position
Cassette Lift Assy Shown at UnLoad Wafer #1 Position
Cassette Lift Assy Shown at Load Position
SECTION VIEW "A"-"A"

Fig 3[a]

Interleaf Feed Mechanism

Figure 4[a] & 5[a] both illustrate the Interleaf feed mechanism from two orientations. Fig. 5[a] removes one side panel and overhead cover to expose otherwise, hidden mechanisms. In addition the Interleaf holder is shown in an open position for fig 5.

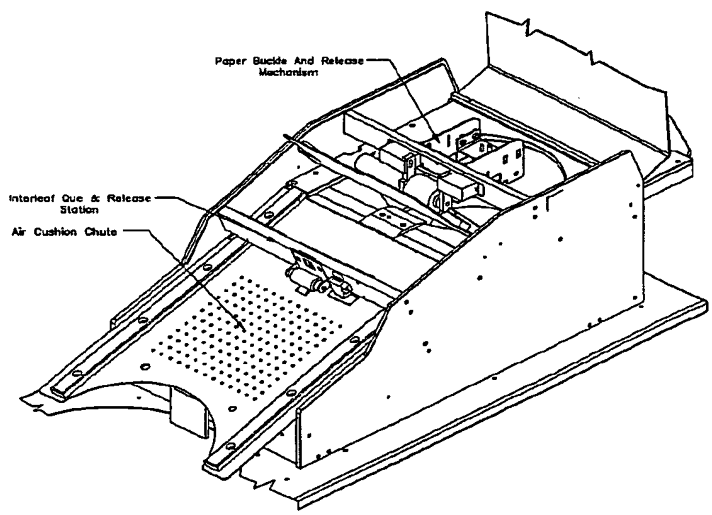



Fig 4[a]

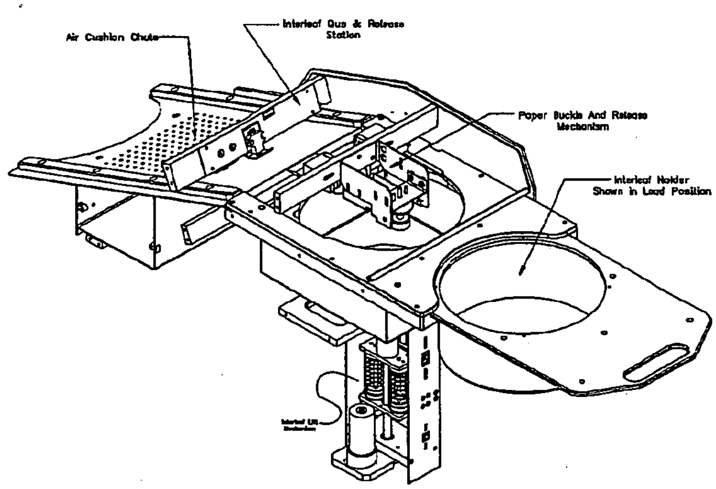



Fig.5[a]

The Sequence of operation begins once interleafs are placed in the holder and the holder is slid inward. A switch "S3 verifies this inward position and two detents provide friction to retain the holder slide in place. Figure 6ª shows the front edge of the drawer slide plate engaging the S3 actuator and Figure 7ª, Section View "F"-"F" illustrates the ball plunger detents engaging machined Spherical shape on the Slide bottom surface.

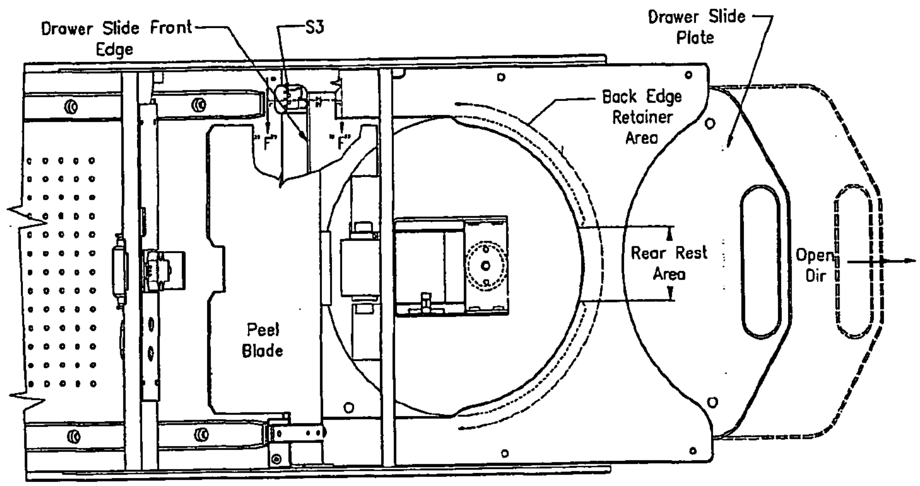



Fig. 6ª

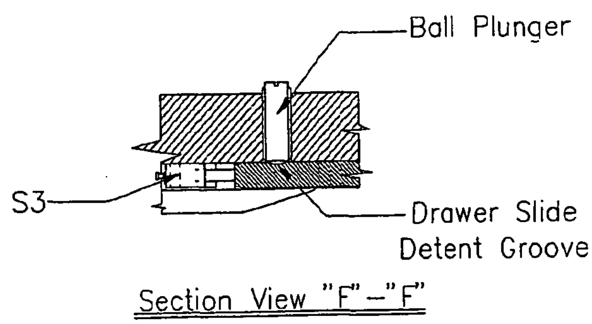



Fig. 7ª

With the Slide drawer in place, the feed sequence begins with the Interleaf Lift Mechanism raising the interleafs up to the Peel Blade and Back Edge Retainer Area applying a constant but controlled force as shown in Fig 11[a]. The Spring Preload distance "between" Support Angle A & B achieve this constant force. Both of these Support angles are mounted to 2-Linear rail bearing Slide blocks, Bearing Block A & B. Both Support angles and bearing blocks have the preload gap/distance maintained by a Threaded rod and Preload Adjustment nut. The threaded rod end towards Support Angle A is attached to a Threaded Spring Post and locked with nut. The Opposite end passes through a clearance hole in a another spring post and through support angle A. On the inside surface of Support Angle A is a Preload adjustment nut, which works against the springs to maintain a distance between both Support angles. The Preload Adjustment nut has a tapered surface, which makes contact with a Preload Sense Switch that indicates the nut is seated against the angle inside surface. During the lift cycle this spring preload force will be exceeded causing Support Angle and Bearing block B to move towards Opposing bearing block and angle A. This movement causes the preload Adjust Nut to move away from the Angle inside surface. This small movement causes the switch to change states and the Preload Motor is turned off. Figure 9[a], views C & D best illustrate this movement.

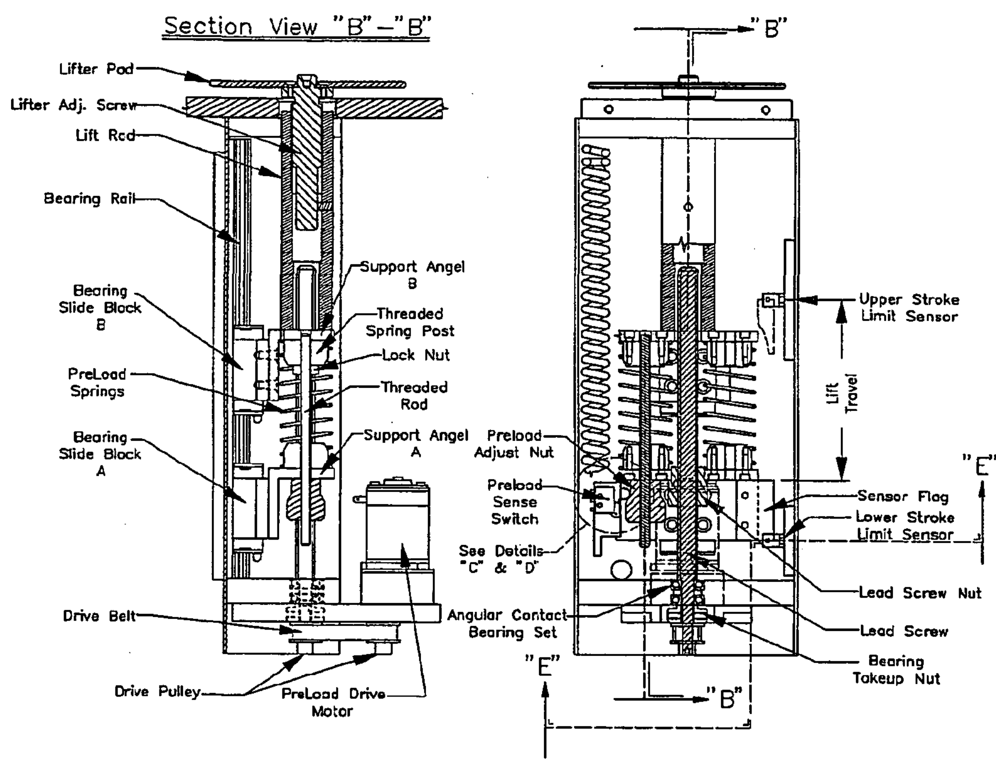



Fig. 8[a]

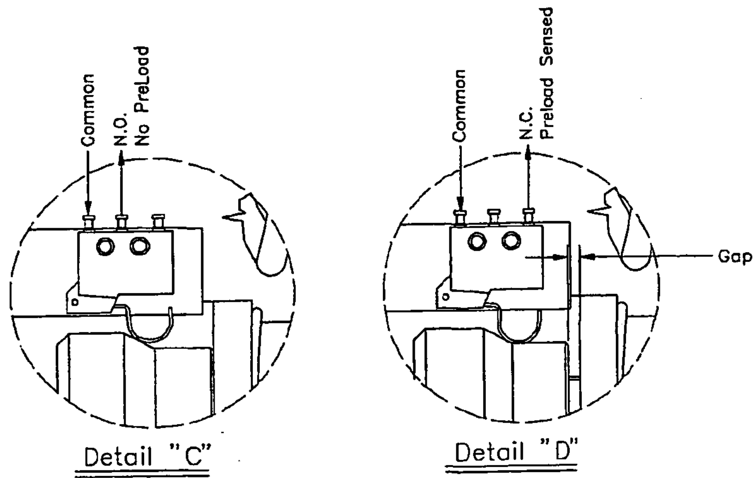
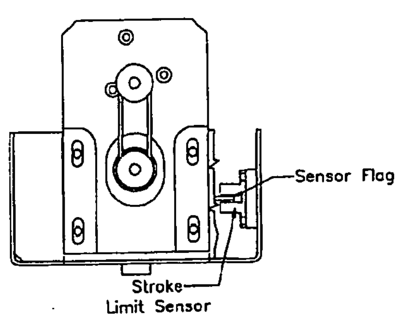



Fig. 9ª

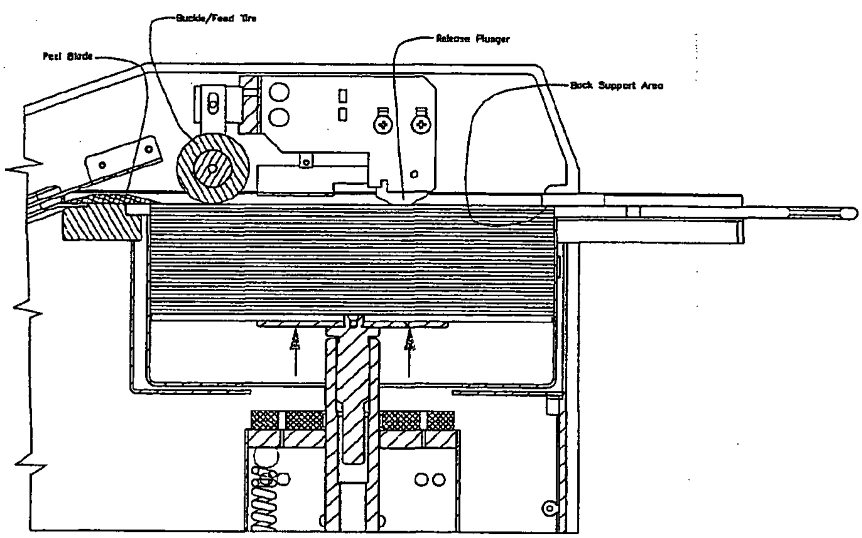
The Lifting motion is achieved via a belt driven Lead Screw that is supported by 2-angular contact (Radial/Thrust) bearings and retained through a mounting block via a bearing take-up nut. The Lead Screw passes through a mating Nut which is mounted to Support angle A, a clearance hole through Support angle B and into the inside diameter of a lift rod.
Activating the rotates the lead screw through a belt drive that causes the nut to move up/down depending on the rotation. In Fig. 8ª, 2-sensors are mounted which control and limit both extents of the Lift travel. Upper / Lower Stroke Limit Sensors are trigger when the Sensor flag interrupts a light beam. This is illustrated, Fig 8ª, with the flag shown at the lower stroke limit position. Fig 10ª shows a view of this flag passing through the sensor. During the upward cycle of raising and preloading interleafs, the preload switch is activated and the motor stops until enough sheets have been stripped from the stack to reactivate this switch and turn on motor again. This Sequence repeats until the Upper stroke limit sensor is blocked. Once this upper limit has been reached and the Take-up Switch activates, indicating no more preload, the motor is reversed until the sensor flag returns back to the starting Lower Stroke Limit Sensor position.




The upper stroke limit sensor is set so that both of these inputs occur approximately at a level where no more interleafs are remaining in the holder

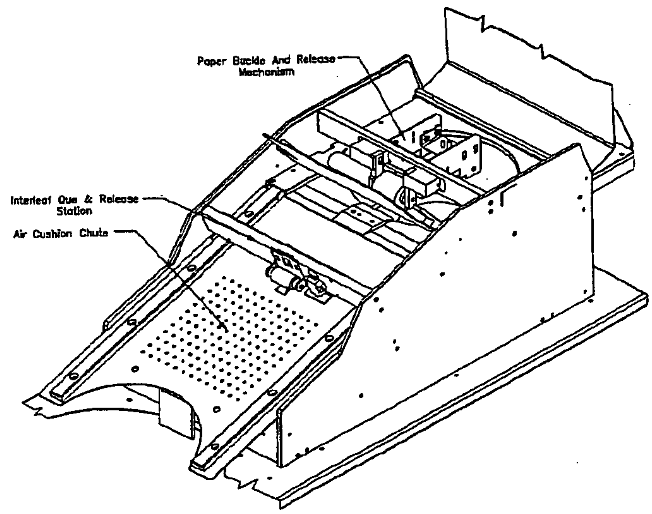
Fig. 10[a]

Illustration 11[a] illustrates interleafs raised up in a position ready for advancing one at a time towards the shipping container. The Lifter Pad shown in Fig. 8[a] moves upward through a opening in the interleaf holder to engage a metal Disc which interleafs are stacked on top of. This disc along with interleafs are raised up until top interleaf is stopped by the Peel Blade and Backsupport area. Once the preload switch activates the motor shuts off and interleafs are ready for stripping one at a time. The back Support area is a Semi circular area which is best illustrated as hidden in Fig 6[a] "Back Edge Retainer" & Rear Rest Area. The Rear rest area is at same contact plane as the peel blade and the two circular "Back Edge Retainer" areas are relieved by a slight amount to keep most preload pressure restricted to the Rear Rest Area.




Interleaf Feed Mechanism

Figure $4^a$ & $5^a$ both illustrate the Interleaf feed mechanism from two orientations. Fig. 5 removes one side panel and overhead cover to expose otherwise, hidden mechanisms. In addition the Interleaf holder is shown in an open position for fig 5.



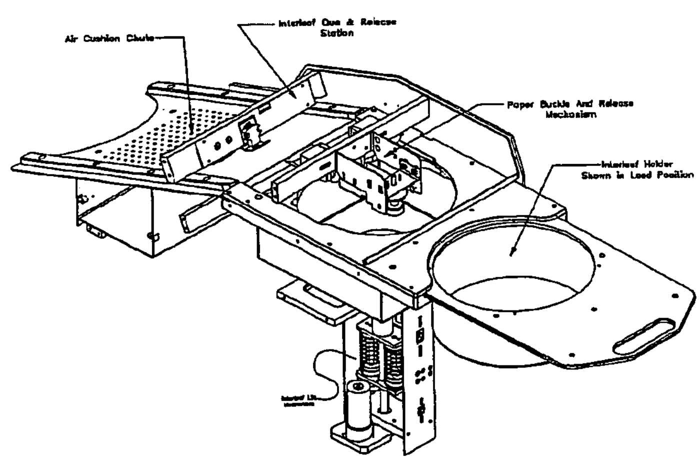




Fig $4^a$

Fig.$5^a$

The Sequence of operation begins once interleafs are placed in the holder and the holder is slid inward. A switch "S3 verifies this inward position and two detents provide friction to retain the holder slide in place. Figure 6 shows the front edge of the drawer slide plate engaging the S3 actuator and Figure 7[a], Section View "F"-"F" illustrates the ball plunger detents engaging machined Spherical shape on the Slide bottom surface.

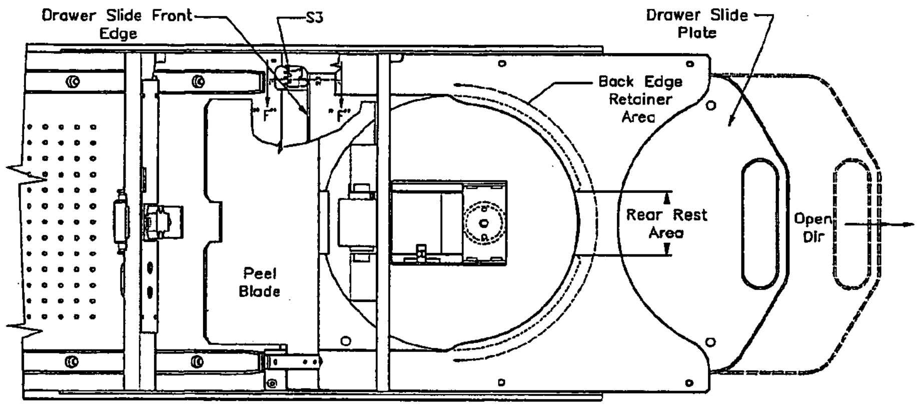



Fig. 6[a]

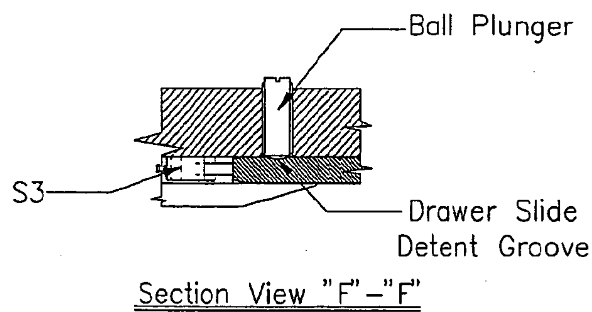



Fig. 7[a]

With the Slide drawer in place, the feed sequence begins with the Interleaf Lift Mechanism raising the interleafs up to the Peel Blade and Back Edge Retainer Area applying a constant but controlled force as shown in Fig 11[a]. The Spring Preload distance "between" Support Angle A & B achieve this constant force. Both of these Support angles are mounted to 2-Linear rail bearing Slide blocks, Bearing Block A & B. Both Support angles and bearing blocks have the preload gap/distance maintained by a Threaded rod and Preload Adjustment nut. The threaded rod end towards Support Angle A is attached to a Threaded Spring Post and locked with nut. The Opposite end passes through a clearance hole in a another spring post and through support angle A. On the inside surface of Support Angle A is a Preload adjustment nut, which works against the springs to maintain a distance between both Support angles. The Preload Adjustment nut has a tapered surface, which makes contact with a Preload Sense Switch that indicates the nut is seated against the angle inside surface. During the lift cycle this spring preload force will be exceeded causing Support Angle and Bearing block B to move towards Opposing bearing block and angle A. This movement causes the preload Adjust Nut to move away from the Angle inside surface. This small movement causes the switch to change states and the Preload Motor is turned off. Figure 9[a], views C & D best illustrate this movement.

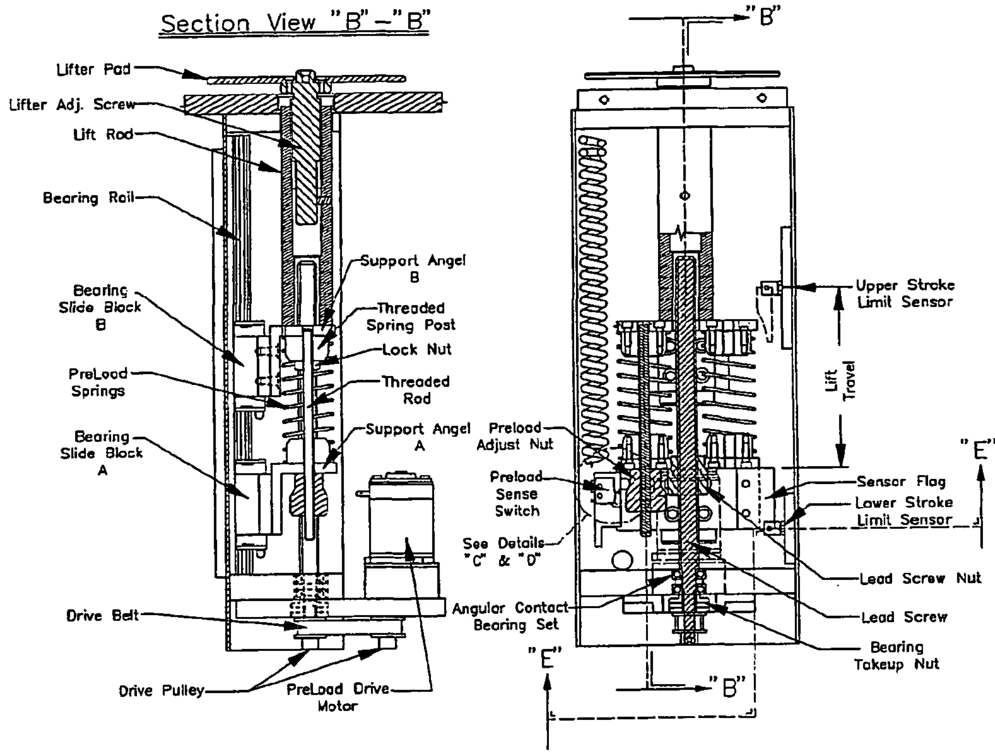



Fig. 8[a]

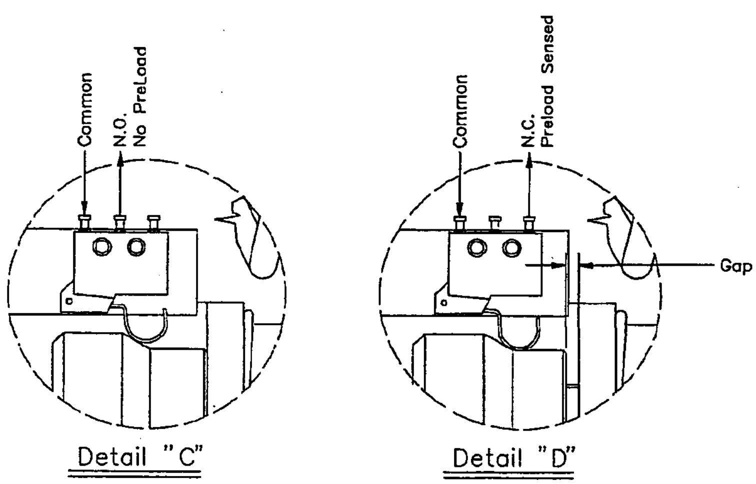



Fig. 9[a]

The Lifting motion is achieved via a belt driven Lead Screw that is supported by 2-angular contact (Radial/Thrust) bearings and retained through a mounting block via a bearing take-up nut. The Lead Screw passes through a mating Nut which is mounted to Support angle A, a clearance hole through Support angle B and into the inside diameter of a lift rod.

Activating the rotates the lead screw through a belt drive that causes the nut to move up/down depending on the rotation. In Fig. 8[a], 2-sensors are mounted which control and limit both extents of the Lift travel. Upper / Lower Stroke Limit Sensors are trigger when the Sensor flag interrupts a light beam. This is illustrated, Fig 8, with the flag shown at the lower stroke limit position. Fig 10[a] shows a view of this flag passing through the sensor.

During the upward cycle of raising and preloading interleafs, the preload switch is activated and the motor stops until enough sheets have been stripped from the stack to reactivate this switch and turn on motor again. This Sequence repeats until the Upper stroke limit sensor is blocked. Once this upper limit has been reached and the Take-up Switch activates, indicating no more preload, the motor is reversed until the sensor flag returns back to the starting Lower Stroke Limit Sensor position.

The upper stroke limit sensor is set so that both of these inputs occur approximately at a level where no more

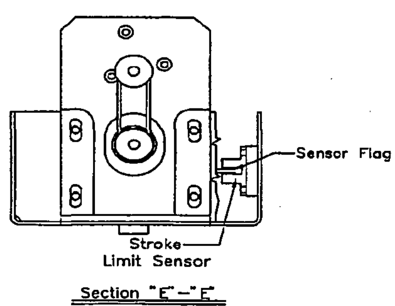



Fig. 10[a]

interleafs are remaining in the holder

Illustration 11 illustrates interleafs raised up in a position ready for advancing one at a time towards the shipping container. The Lifter Pad shown in Fig. 8[a] moves upward through a opening in the interleaf holder to engage a metal Disc which interleafs are stacked on top of. This disc along with interleafs are raised up until top interleaf is stopped by the Peel Blade and Back support area. Once the preload switch activates the motor shuts off and interleafs are ready for stripping one at a time. The back Support area is a Semi circular area which is best illustrated as hidden in Fig 6[a] "Back Edge Retainer" & Rear Rest Area. The Rear rest area is at same contact plane as the peel blade and the two circular "Back Edge Retainer" areas are relieved by a slight amount to keep most preload pressure restricted to the Rear Rest Area.

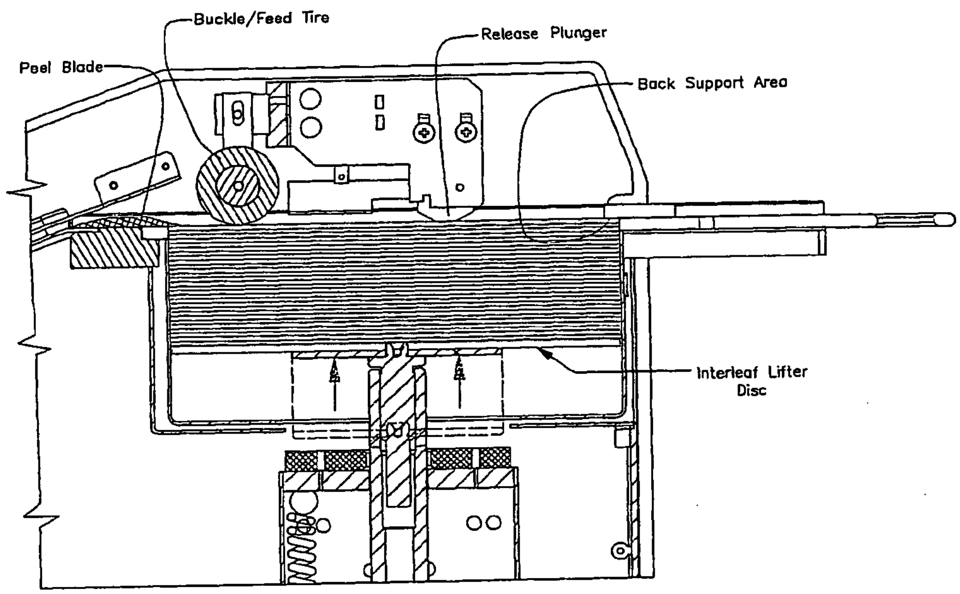



Fig. 11[a]

The next part of the sequence will be to separate 1-interleaf from the rest. This sequence begins by activating Separator Motor "O2" which drives the Buckle/Feed Tire. The rotation direction is C.C.W. (illustrated in Fig. 12[a].) which slides the top sheet towards the back Support area causing the interleaf to bow upward. As the interleaf bows upward, contact with the Buckle paddle occurs. This "U-Shaped" Paddle pivots upward within a gap "Buckle Sensor " to confirm paper has slipped out from under the Peel motor. Once this has been detected, the peel motor is stopped. This Sensor can be adjusted to allow more or less buckling to occur. Fig 13 is viewed at "G"-"G" at and offset from horizontal plane to best show this relationship of the Buckle sensor & Buckle paddle.

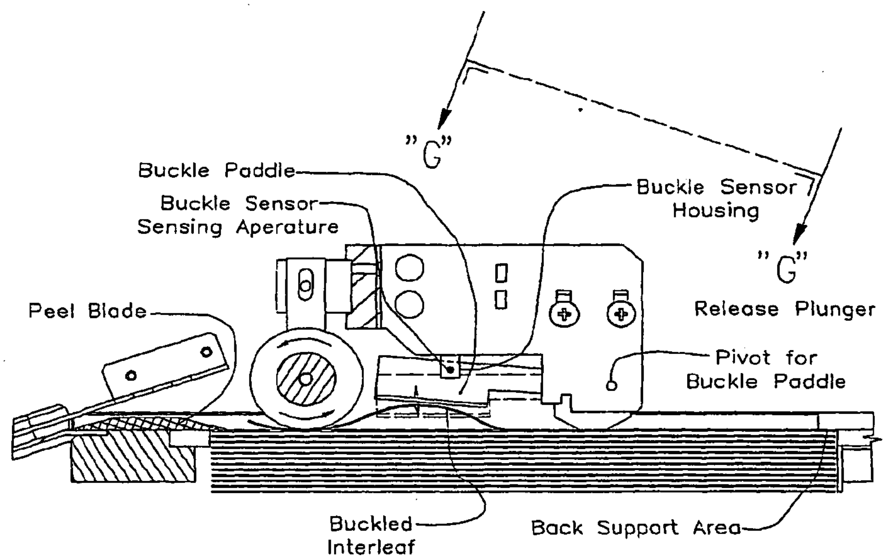



Fig 12[a]

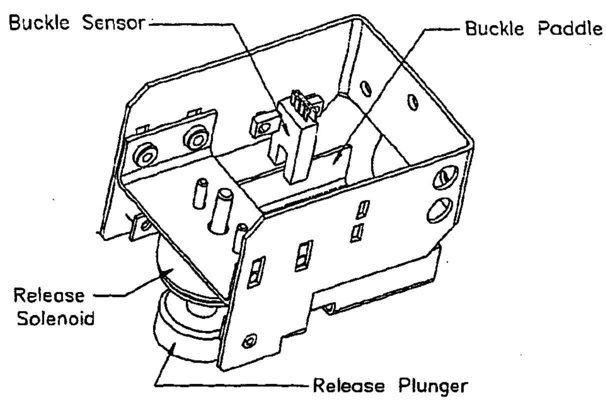



Fig 13[a]

The Sequence continues by turning back on the Separator Motor "O2" in an opposite C.W. direction along with the Interleaf Release/Stage Wheel.

This feeds the interleaf towards and up over the knife-edge on the peel blade. The interleaf continues being feed forward to the overhead Interleaf deflector, which guides the interleaf towards the Que & Release Mechanism. Feeding continues until the Front circular edge is Detected at S7 "Interleaf @ Release" Reflective sensor. At this moment in the sequence, both ends of the interleaf are being pushed /pulled by both drive tires and it is necessary to turn off the Separator motor to prevent motors working against each other. To accomplish this without creating drag from the trailing/ back edge of the interleaf, a push solenoid connected to a release plunger is activated just before stopping the Separator Motor. This pushing action on the next interleaf and remainder in holder removes most of the preload on the stack so the trailing portion of the interleaf can be pulled out and from under. The Separator tire This pushing action by the solenoid is only needed for a short duration and therefore the pulse duration of under one second is sufficient for back edge to clear the Peel blade.

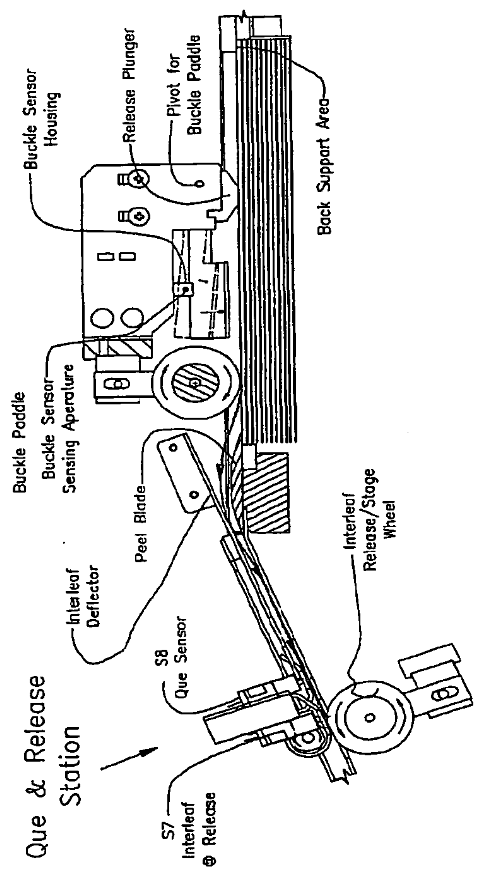



Fig 14ª

The Interleaf Release /Stage Wheel continues to advance the interleaf until the trailing edge, circular portion, is detected. Once detected this motor is shut off and braked to retain the now staged interleaf. With Sensor S7

being off center from the interleaf centerline this allows the trailing edge to be detected while the center portion in still gripped by the Interleaf Release /Stage Wheel & overhead Idler wheel. Fig 15[a] illustrates this relationship.

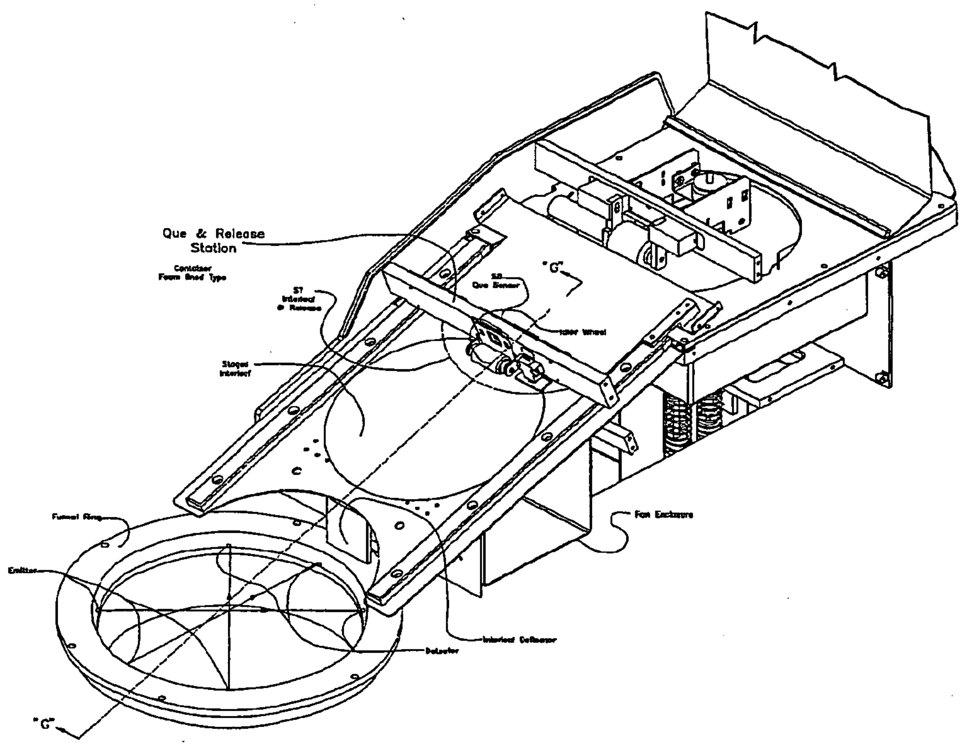



Fig 15[a]

The last part of the sequence will be releasing the staged interleaf to the Container Funnel Ring.
First a fan motor underneath the chute is turned on to provide a air cushion underneath the interleaf and then the Interleaf Release /Stage Wheel is turned back on to release the interleaf. The interleaf floats down the inclined chute surface, which is targeted and inline to a Funnel ring.
The funnel ring upper and tapered diameter is enlarged to provide more clearance for the interleaf to enter.
The Smaller diameter end is sized to be smaller then the foam liner in Fig 16[a] to assure a clear entry into the container. This ring mounts into a housing that houses 3-emitter/detector pairs that form a light curtain at the Funnel Ring Inside Diameter. Upon any one of these pairs sensing the interleaf, The Interleaf Release/Stage Wheel is turned off. These sensors continue to be monitored until all are unblocked which indicates the interleaf has passed through into the container.

At this point the next Interleaf can be advanced up to the staging area and await for a release command from the system.

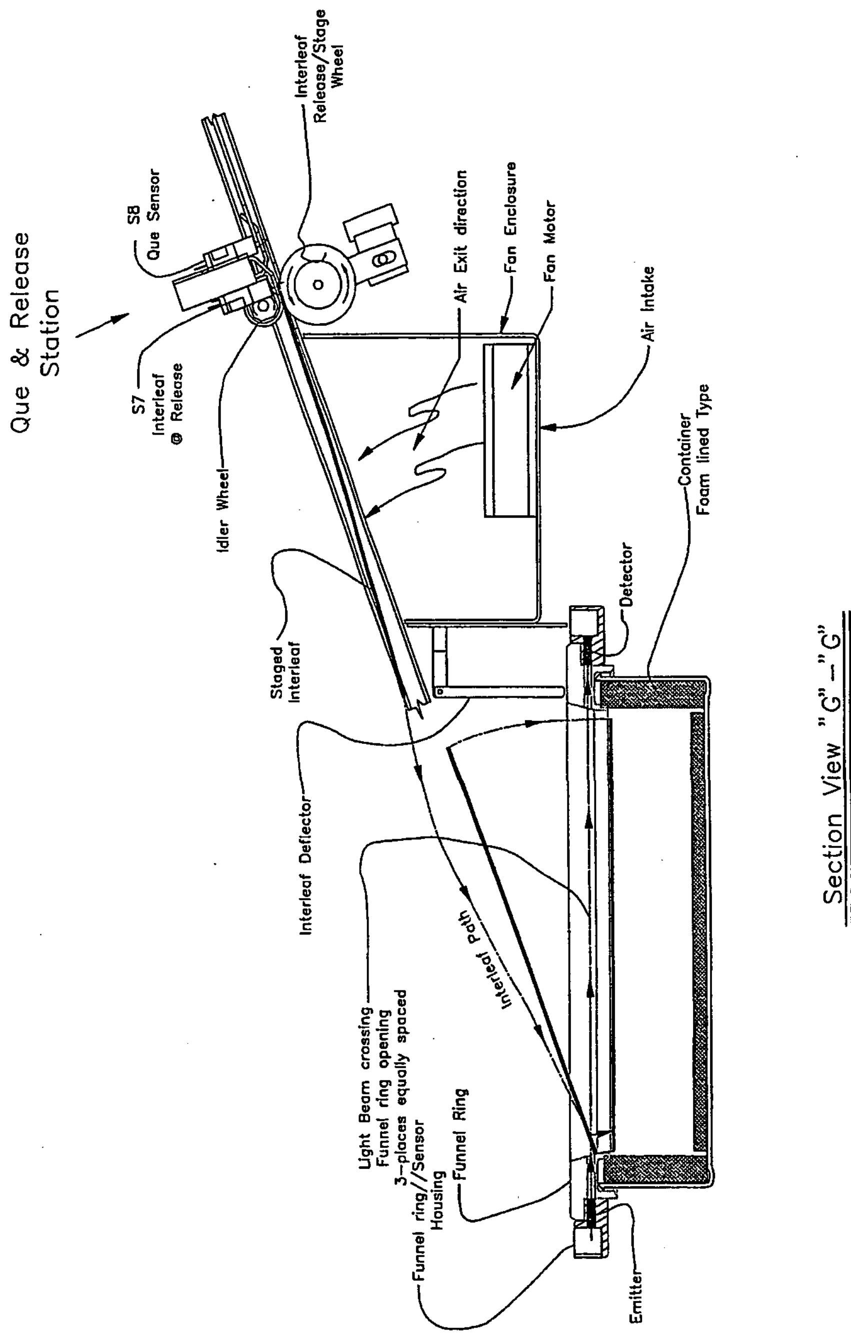

Que & Release Station
S8 Que Sensor
Interleaf Release/Stage Wheel
S7 Interleaf @ Release
Idler Wheel
Air Exit direction
Fan Enclosure
Fan Motor
Air Intake
Container Foam lined Type
Staged Interleaf
Detector
Interleaf Deflector
Light Beam crossing Funnel ring opening 3-places equally spaced
Interleaf Path
Funnel ring//Sensor Housing
Funnel Ring
Emitter
Section View "G" – "G"

Fig 16[a]

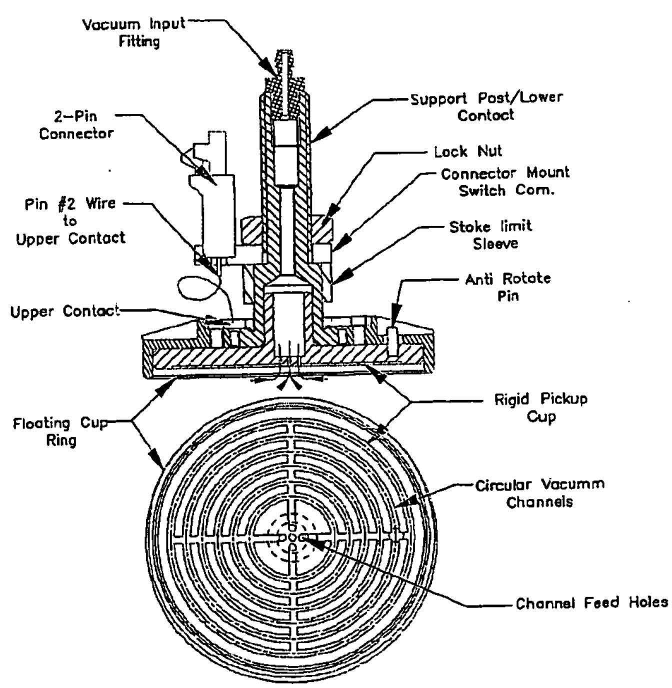
Key features of this Interleaf Station are:

1.) Consistent force preloading of Interleafs
2.) Method to buckle the interleaf and sense the buckle shape.
3.) Funnel ring to guide interleaf freely into the shipping container.

Wafer Pickup and Transfer
To Container/Jar

A good understanding of how the Pickup cup functions first is necessary before explaining the Wafer Pickup and transfer.
The prior use of sensing with a gap sensor and vertical arm mounted flag has been changed to eliminate the rubber cup. Though rubber is suited in many instances it is objectionable since it gives off microscopic particles. The rubber cup did however provide the benefits of picking up irregular and non-plumb surfaces due to inherent flexing properties.
Therefore is became necessary to develop a more compliant plastic material cup with properties similar to current handheld Vacuum pickup tools used for manual transfer operations.
Use of a Rigid plastic cup in an automated system becomes difficult because of alignment issues. The potential for both the wafer pickup surface and cup pickup surfaces being out of parallel is a normal condition. Thought this error may not great, in can be enough to keep enough space between the surfaces to prevent vacuum to be achieved. Typical resolve for this would be to have higher flow vacuum to help compensate. We found this to be the case upon replacing the rubber cup with a rigid cup. The cup would basically make contact with the wafer, vacuum would be turn on, the cassette stop feeding and system would time-out waiting for 22" of vacuum pull to be reached. Making alignment adjustments improved pickup process, but at best a 50/50 chance.

Fig.17[a]



The pickup cup shown in Fig 17a Consist of a threaded "Support Post/Lower Contact" which is extended downward to the Rigid pickup Cup where it widens (flanges) forming 1-side of an electrical contact. The bottom end of this part is bored out to allow a press fit of the Plastic "Rigid Cup. A center hole is bored through the center to allow vacuum to be pulled from the fitting down to the rigid cup and out through tiny holes that feed a pattern of circular grooves. The necessity of these grooves is to provide enough holding area/volume to securely hold the wafer during transport.
Above and around the rigid cup is the "Floating Cup Ring" which slips over and on top of the rigid cup. At the topside of this floating cup is a recess, bored pocket that mounts and secures the "Upper Contact". The contact is at an elevation where it rests on top of flange of the "Support Post/Lower Contact", thus forming a N.C. (normally closed) Switch. Both mating surfaces are gold over nickel-plated to prevent oxidation, prolong life expectancy and allow easier ability to solder wire to the "Upper contact".
The wire soldered to the "Upper contact" is connected to a "2-pin Connector", Pin #2 which is secured to a "Connector Mount Switch Common". Within this "Connector Mount Switch Common" part are two holes for the "2-pin Connector" to pass though. The hole at Pin #2 where the wire attaches is enlarged to prevent contact with the "Connector Mount Switch Common". This also allows room to allow for heat shrink tubing to strain relief this connection. The hole at Pin #1 is close fitted to the 2-pin Connector to allow for soldering and making contact. The connection between "Connector Mount Switch Common" and "Support Post/Lower Contact" is achieved by clamping the two together via a lock nut. Thus Pin #1 is now connected to the lower contact flange. Electrical isolation is maintained via the isolation properties of the plastic "Rigid Cup" & "Floating Cup Ring".
At the right hand side of the "Rigid Cup" is a Plastic "Anti Rotate Pin" which passes through a clearance hole in the "Floating Cup Ring". This eliminates rotation between these two parts that would otherwise be seen by the wire attached to "Upper Contact".
To assure this "Anti Rotate Pin" cannot disengage, a plastic stroke limiter is positioned above and retained via press fit onto the "Support Post/Lower Contact".

The electrical state shown in figure 17a, is a normally closed switch where contact is achieved via the bottom surface of the "Upper Contact" and the top flange surface of the "Support Post/Lower Contact". This connection is purely maintained by the weight of the "Upper Contact"/ "Floating Cup Ring" combination.

Figure 18[a] illustrates a wafer moving up non-parallel to the "Rigid Cup" during the raising of the Wafer Cassette. The first area to make physical contact with the wafer is the "Floating Cup Ring"
The first item that occurs is the upper contact opens followed by the vacuum is turned on. The wafer upward movement continues raising a small amount further, which is programmable before for stopping.
This additional travel allows the "Floating Cup Ring' to seat on the wafer surface and compensate for mis alignment. This essentially forms a very large area of vacuum to lift the wafer up to the rigid surface

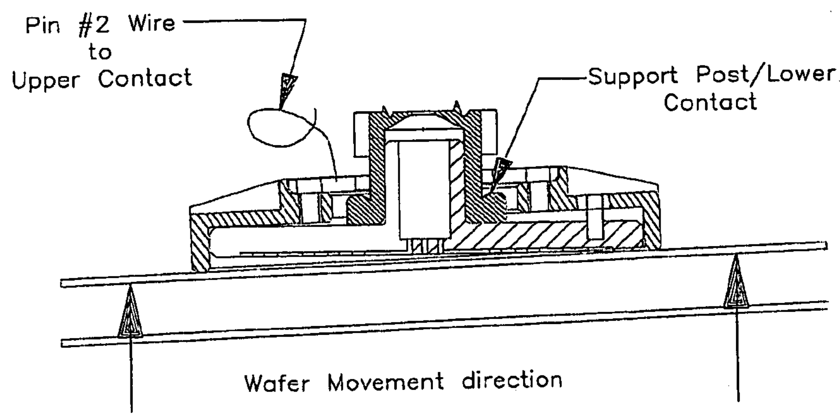



Fig 18[a]

Figure 19[a] illustrates the wafer lifted and pulled up against the rigid cup. Once vacuum is sensed, the machine is ready to transfer to the Shipping container/Jar. One item to note is that once the wafer is sealed up against the Rigid cup, the Floating ring is completely free and essentially just sitting in a raised position.

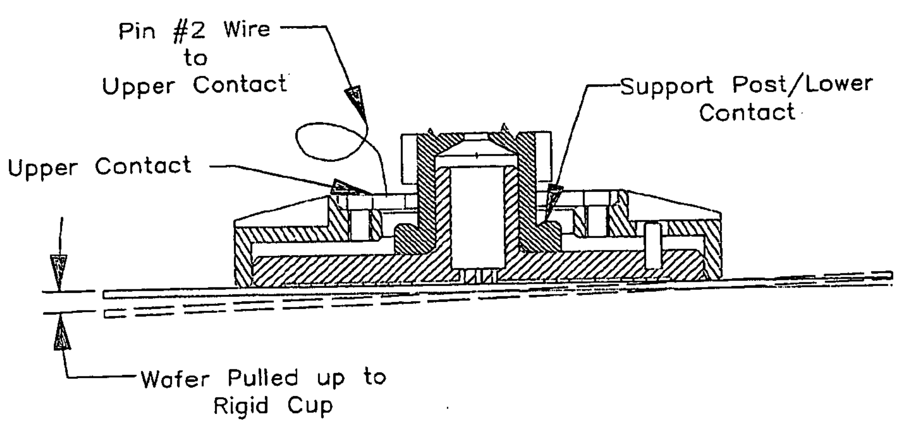



Fig 19[a]

The cup assembly Shown in figure 17ª is mounted to a plastic and non-conductive housing that prevents the upper "Support Post/Lower Contact", portion, signal ground, to short to the machine ground.
This "U"-Shaped upper plastic housing, slips around a steel slide and is mounted to a plastic "Switch Cap" Both plastic parts bolted together leave a rectangular hole for the Slide to pass through forming a linear/vertical slide bearing. To keep the two plastic parts from slipping off the steel slide, A pin is press fitted into the slide, "Slide Pin', and a pocket is cleared through the switch cap. This now reduces the vertical slide travel to the length of the slot. As illustrated in a vertical orientation, the weight of the two plastic parts and cup assembly, all weight is hanging and supported by the Slide pin.
Within the "Switch Cap", a lever actuated ": Switch" is positioned to allow the lever portion to be within the slot area of the "Slide Pin " This allows sensing the pin is at the upper end of the slot. To protect the switch lever from over travel, an " Adjustment Stop" is mounted to the outside of the switch cap to reduce the travel of the slot along with over travel on the switch lever. Typically set just past the triggering point of the switch so that the slightest lifting of the cup and slide assembly triggers this switch.
The far right backside view in figure 20ª illustrates the assembly raised off the Slide pin.

This additional input provides a backup to the Cup Switch while wafers are being raised but will have another role upon the additional vertical stoke option incorporated into this machine. This additional vertical motion option will be for lowering wafers to the bottom of the shipping container. Once a wafer is picked up and held with vacuum, the switch within the cup is in a N.O. condition until the cup is release and therefore sensing when the bottom of the container is reached will be the responsibility of this switch.

This basically covers the slide and floating pickup cup assembly and should understanding the sequence of wafer transfer from Cassettes to Shipping Jars hereafter.

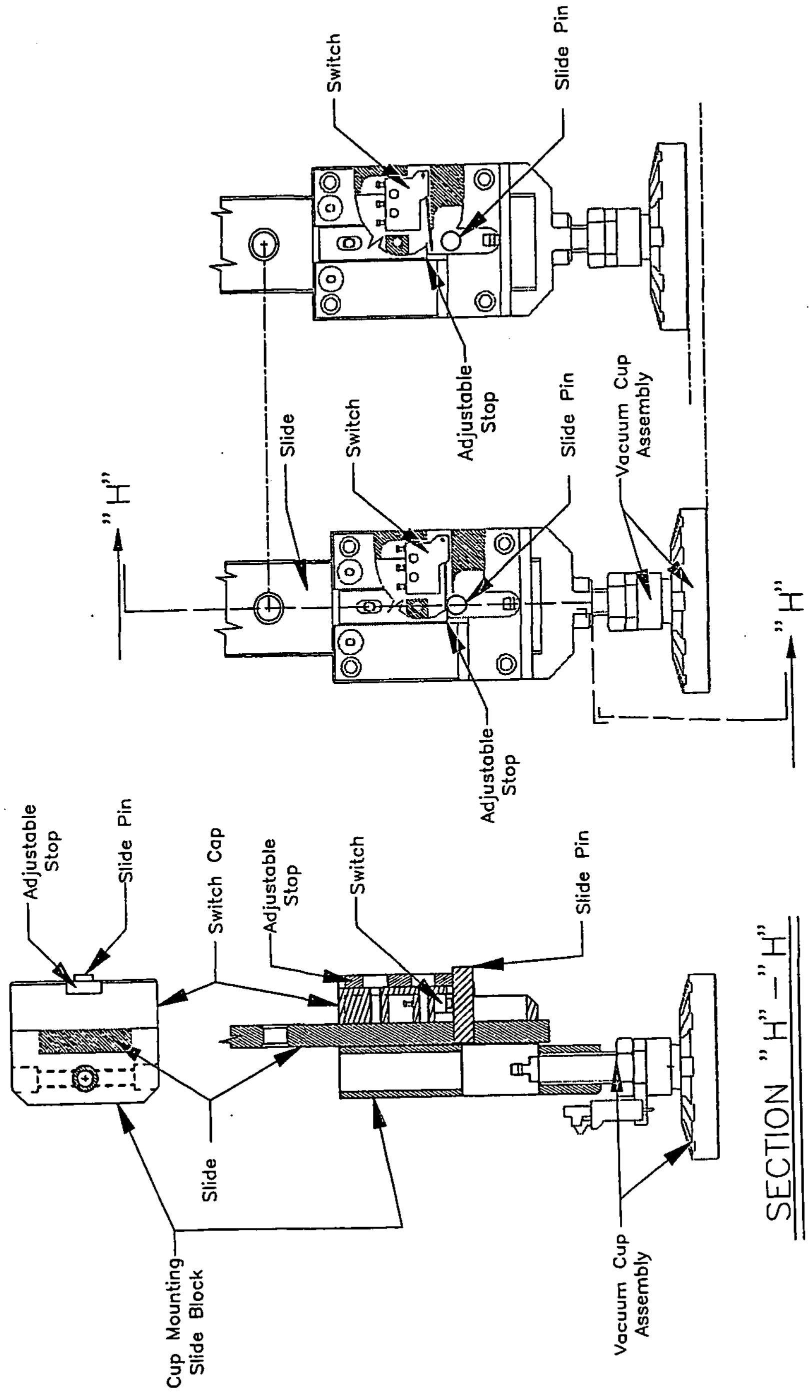

Switch
Slide Pin
"H"
Slide
Switch
Adjustable Stop
Slide Pin
Vacuum Cup Assembly
Adjustable Stop
"H"
Adjustable Stop
Slide Pin
Switch Cap
Adjustable Stop
Switch
Slide Pin
Slide
Cup Mounting Slide Block
Vacuum Cup Assembly
SECTION "H"–"H"

Fig 20[a]

The Transfer begins once a Wafer cassette has been installed into a Cassette Holder Assembly in an orientation where H-bar is position upward. Incorporated into this holder is a switch that verifies the Cassette has been loaded in a correct orientation.
Fig 21[a]. Is a top plan view that shows both positions of the pickup arm and Fig 22[a] is a side cutaway view.

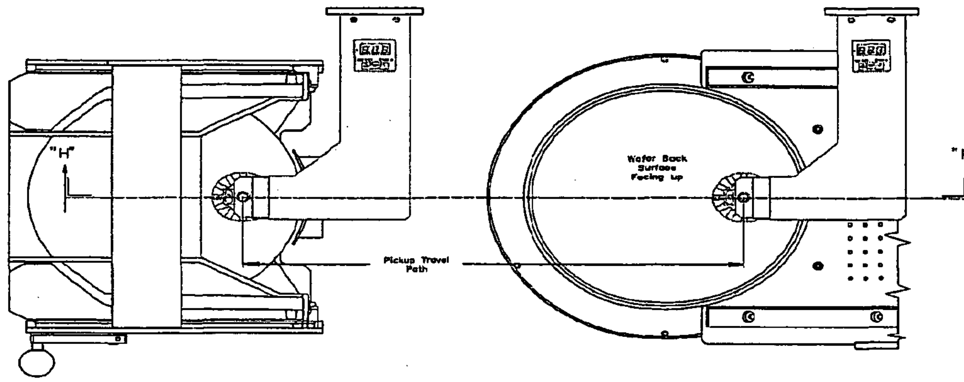



Fig.21[a]

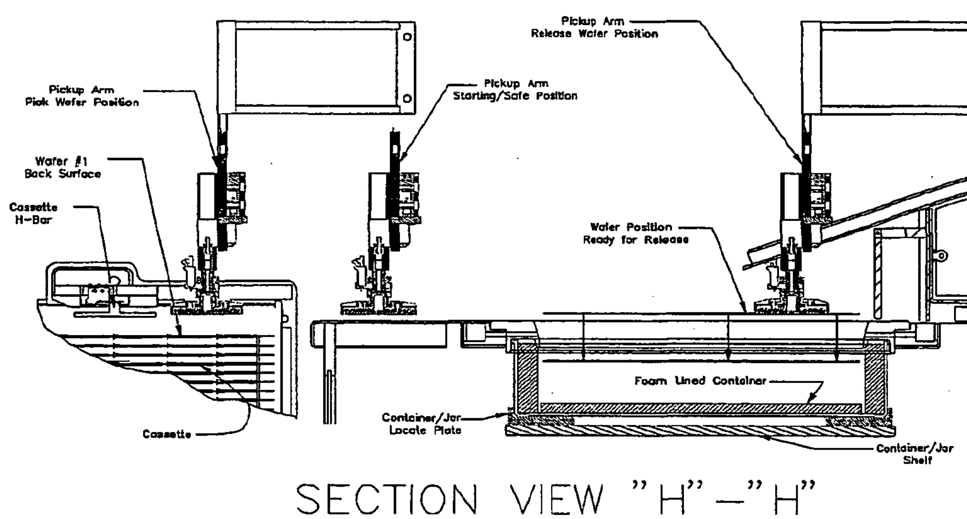



Fig.22[a]

Once all startup conditions have been met the Pickup arm moves from the Safe position to overtop of the cassette. The cassette is then moved upward to a starting position and from that point, is moved upward at a slower rate towards the Cup Assembly.
Within a few mils of contact between the Floating Cup and the Wafer Back Side, the switch opens and the vacuum is turned onto the cup which then lifts the Wafer to the rigid Cup surface. This is confirmed via a Vacuum sensor mounted or the Arm assembly, which verifies the vacuum, pull.
In addition, this Lifting action raises the Wafer off of the Cassette grooves, thus centering so the wafer can easily be slipped out. See Fig 23ª & 24ª

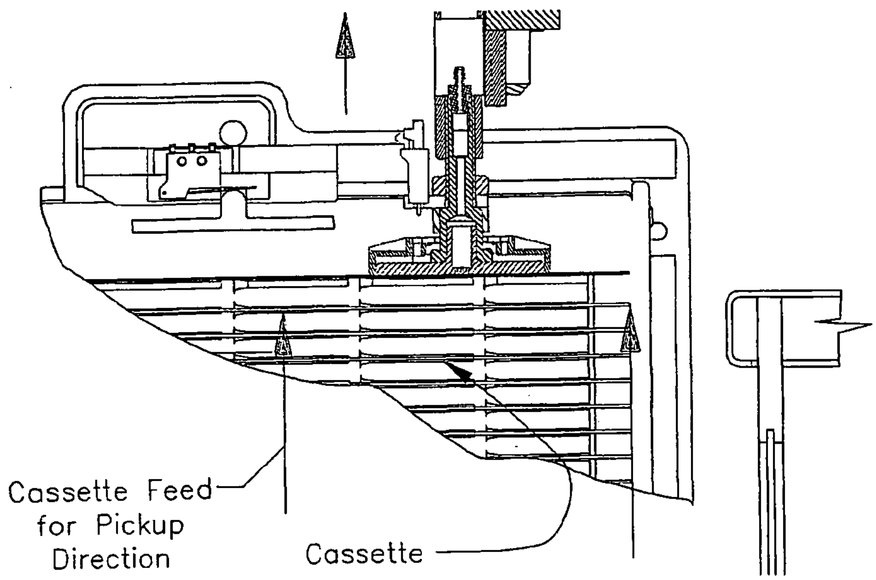



Fig. 23ª

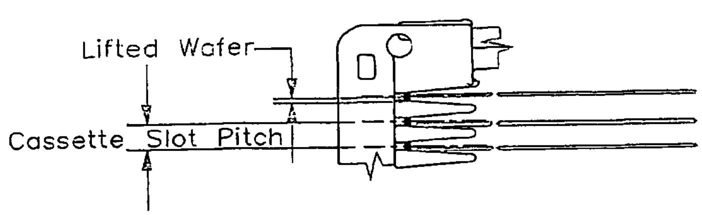



Fig 24ª

Assuming that the interleaf completed the cycle of placing in the Container, the Pickup arm is free to move towards the unload/ Release Position shown in fig 22[a]. Once in position the vacuum is turned off to the cup,the wafer releases and drops into the Container. The 3-Funnel ring Sensors verify the Wafer has entered the Container and cleared the Sensor beams. The container illustrated is a foam lined that docks onto tapered geometry at the bottom side of the Funnel ring. This docking action tucks the foam line peripheral liner away from the path of the released wafer. The released wafer upon entry to the funnel ring encounters an air cushion formed by trapped air in the container that decelerates the wafer.

For non foam lined containers the wafer can be lowered to the bottom of the container before releasing with only consequence of an increased cycle time.

At this point in the cycle the Pickup arm is moved back to the cassette and The Interleaf feed mechanism releases another Interleaf. This cycle repeats until the desired amount of wafers has been placed in the container. Upon the last wafer being placed the Pickup moves back to the Safe/Starting position and one last interleaf is placed in the Container to prevent contact with the foam pad.

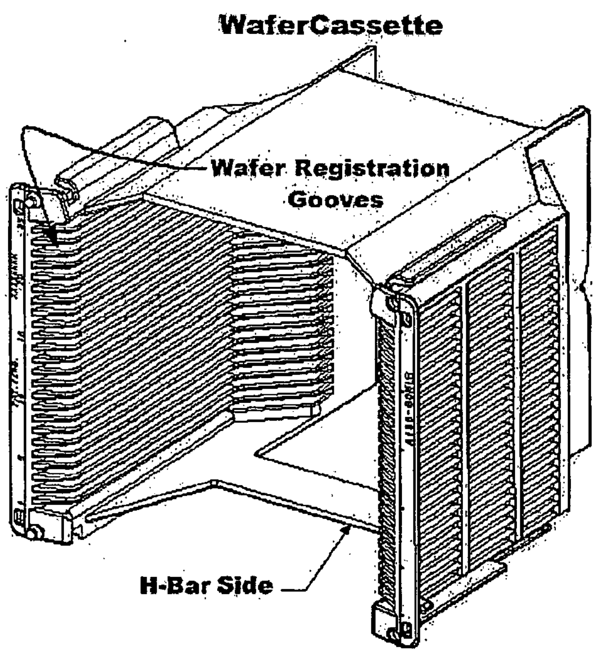



Fig. 25[a]

# Control Panel Settings

**Depress Setup Key and display will show numbers 1 & 2.**

| Setup# | Description |
|---|---|
| **1. Interleaf Options.** | |
| A.) Interleaf number to drop pre | (Default=0)This number adds to the Interleaf amount set for between wafers for the first wafer. |
| B.) Interleaf number to drop bet | (Default =1)This is the number of interleaf's to be placed between each wafer and includes both the start and end amount as well. |
| C.) Interleaf number to drop aft | (Default=0)This adds ending number of interleaf's to the amount set between wafers. |
| D.) QUE at S8 | (default=off) This option if turned on speeds up the Interleaf sequence by advancing the next Interleaf to S8 versus from the interleaf stack Note! Before this option is to be activated S8 must be adjusted to Sense/trigger on a interleaf being present. Visible indicators and Trim pot are present on the sensor for Adjusting the trigger point. |
| **2. Position Sets** | |
| A.) Cassette Load | (default= -7,900) This is a step position, relative to home sensor where the Cassette is positioned at time of loading. |
| B.) Cassette Start | (default = -100) This is a step position, relative to home sensor where the Cassette is moved to before fore going into a slow feed mode towards the Pickup cup. |
| C.) Positions Cass stop Scan | (default= 38750) default for Compliant Cup. **Note if rigid cup Installed set this value to (37000)** |
| D.) Arm Load | (default = +4,800) This is a step position, relative to home sensor where the Pickup Arm is positioned after homed. Positioned clear of the Cassette |
| E.) Pickup Wafer | (default= -1,780) This is a step position, relative to home sensor where the Pickup Arm is positioned over the Cassette for wafer pickup. Note! For non-rubber cups larger in diameter this number should be reduced and tested prior to larger Cup installation to prevent a Crash with cassette. |
| F.) Arm Drop Wafer | (default= +16,190) This is a step position, relative to home sensor to the Jar Drop interleaf position. Note that on Proto machines this number is within a 100-200 counts from the limit over travel sensor. Therefore increase in small amounts. |
| G.) Interleaf Drop. | (default= +10,000) This is the point at which the next interleaf can be dropped While the pickup arm is heading back to the pickup position. |
| H.) Positions cup center travel | (default= -600) backup value to center wafer in cassette guides. **For rigid cup this value should be changed to 0.** |

3 **Timers** **All numbers in Seconds**

A) Motor O1 Timeout (default=5.00) Timer to allow stack to be raised to input present. Time is to Protect motor in the event the preload switch or upper limit sensor not being reached.

B) Interleaf to S6 (default=10.00) This is the time allowed for the Interleaf to be peeled backwards until sensed by the buckle Sensor S6

C) Interleaf to S6 Delay (default=.15) This is the time after S6 is triggered that the peel motor continues to run or over travel.

D) Interleaf O16 Pulse (default= .50) This is the time the Release solenoid, at paper feed station Remains fired downward to release the interleaf being advanced.

E) Interleaf to S7 (default=3.00) This is the maximum time allowed for the interleaf to be feed from the peel motor to the Chute release motor.

F) Interleaf to S9,10,11 (default = 5.00) Time allowed from time interleaf is released to reaching one of the sensors verifying the interleaf has entered the Jar/Container

G) Interleaf Drop (default= .70) This is the time period for which the release motor will run To release Interleaf towards the Jar/Container station.

H) Wafer Drop to S9,10,11 (default=2.00) Time allowed from releasing wafer to jar until reaching Sensors around Jar/Container opening

I) Unload Stack (default = 120.00) This is the time allowed if the machine is paused, where the interleaf stack will be lowered to initialized position. This timer is to prevent the interleaf from taking a set curved position from sitting in a buckled state for any lengthy period

J) Power Save Mode (default = 300.00) This is the timeout period in seconds where if the machine sits idle, power to motors and pump will be shut down. Pressing Start turns power back on for running machine

**Maximum Values**

A) Large Jar S13 (default=30) This is the default maximum number which the operator can Enter for a large jar/Container

B) Small Jar S12 (default=25) This is the default maximum number which the operator can Enter for a small jar/Container

**4.) X Axis Performance** **Pickup arm Move speed**

A) Acceleration (default =400) Acceleration rate

B) Deceleration (default= 40 ) Deceleration rate

C) Jerk (default = 20) this is a S-curve parameter and if value set to 00 the move Profile changes to Trapezoidal

D) Max Speed (default = 1,000,000) This is the maximum speed in pulses per second allowed. Actually never gets this high due to the move distance.

**5.) Press Diag to restore Factory Defaults**

This allows for resetting all above values to the default settings

**7.) View Code Rev** Display should show the following

Display= > *Wafer Jar Loader*

*Mod:325-6000 Rev1FF*

The number "1" designates the machine generation

The First letter "F" indicates the processor code revision

The Last letter "F" indicates the OIT code revision

Upon entering changes and exiting ,where the display indicates settings have been saved, the E-stop can be re-set to run and test these new changes/adjustments.

## Diagnostics

Diagnostics have been added to revision C software which allows visual feed back of all inputs on the Jar loader. The Wiring pictorial schematic should be used in conjunction if not familiar with each sensors name and input number. Upon entering this mode, the Inputs are spread out over two displays due to the number of I/O's.

The secondary line displayed with 1's & 0's indicates each sensor state form the controls. These are setup in a left top right format which means the leftmost is S1 or input number one. The rightmost would be S16 or input 16.

To get a feel for how used just open and close the Jar shelf handle while viewing the first 16 inputs. Depending which position the shelf is in either S12 or 13 will change states.

## CLAIMS

What is claimed is:

1. A method for packaging wafers having a bottom side and a top circuit side in containers comprising the steps of;

placing a cassette having a plurality of pockets for wafers with the back side facing upwardly,

transferring the top wafer in the cassette by means of a vacuum suction mechanism which centers the top wafer in the cassette pocket upon initial engagement and

transferring and discharging the wafer to a container located at a container station and feeding interleafs in timed relation to the wafer feed so that an interleaf is positioned between each wafer loaded in a container.

2. A method as claimed in Claim 1 including the step of centering the wafer in the pocket of the cassette before withdrawing it from the pocket by the vacuum suction mechanism.

3. A method as claimed in Claim 1 including the step of levitating the interleaf as it traverses a chute guiding the interleaf from the interleaf station to the container.

4. A method as claimed in Claim 1 including the step of maintaining a predetermined stacking pressure on the interleafs at the interleaf transfer station.

5. A method for packaging wafers having a bottom side and a top circuit side in containers comprising the steps of;

placing a cassette having a plurality of pockets for wafers with the back side facing upwardly,

transferring the top wafer in the cassette by means of a vacuum suction mechanism which centers the top wafer in the cassette pocket upon initial engagement,

transferring and discharging the wafer to a container located at a container station and feeding interleafs in timed relation to the wafer feed so that an interleaf is positioned between each wafer loaded in a jar and

activating the vacuum suction mechanism linearly only between opposing limit positions to achieve a direct transfer of wafers from a wafer loading station to the container station.

6. In a system for packing wafers in a jar compromising a first wafer station wherein a plurality of wafers are mounted in pockets of a cassette with the circuit side of the wafer facing downwardly in the cassette, a suction pick up mechanism for transferring one wafer at a time from the wafer loaded station to a jar loading station, means for advancing the cassette as wafers are removed and said suction pick up positioning the wafers centrally in the pocket before transfer and means for feeding an interleaf in predetermined timed sequence with the wafer transfer to position an interleaf between each wafer delivered to the jar at the jar station.

7. Apparatus for delivering disc like interleafs one at a time comprising an interleaf holder, a peel blade and a back support overlying an edge of holder, means for maintaining a predetermined pressure of the interleaf stack against the peel blade and back support as interleafs are removed from the holder, a buckle feed roller overlying the stack of interleafs including means for rotating the roller in one direction to release the front edge of the top most interleaf from the peel blade so that the front edge can engage over the ramp of the peel blade means for rotating the roller in the opposite angular direction to release the rear edge of the interleaf held by the back support to advance the upper interleaf to a discharge station.

8. A system is claimed in Claim 6 wherein the vacuum suction mechanism comprises a rigid disc-like cup member having a plurality of channels on its outer face which communicate through holes with a vacuum source and an outer floating cup ring, tiltably mounted over the rigid pickup cup including mean for preventing relative rotation of said floating cup ring and pickup cup, said cup ring having an outer peripheral wall which in the seated position extends below the plane of the bottom face of the rigid pickup cup member to provide a compliant function when the suction mechanism is positioned to pick up a wafer at the wafer loading station.

9. A system is claimed in Claim 8 including cup and support post contact means which are normally engaged when the outer floating cup ring is seated on the rigid pickup cup and disengage when the rim of the rigid pickup floating cup engages a wafer to initiate activation of the vacuum system.

10. A system is claimed in Claim 8 wherein the axial displacement distance of the rigid pickup cup in the outer floating cup ring is such that the wafers are relatively centered in the pocket upon disengagement of the contacts to initiate activation of the vacuum displacing the rigid cup in the floating cup ring.

11. A vacuum suction mechanism comprising a rigid disc-like cup member having a plurality of channels on its outer face which communicate through holes with a vacuum source and an outer floating cup ring, tiltably mounted over the rigid pickup cup including mean for preventing relative rotation of said floating cup ring and pickup cup, said cup ring having an outer peripheral wall which in the seated position extends below the plane of the bottom face of the rigid pickup cup member to provide a compliant function when the suction mechanism is positioned to pick up a wafer at the wafer loading station.

12. A method for packaging wafers having a bottom side and a top circuit side in containers comprising the steps of;

placing an inverted wafer loaded cassette in an automatic machine for transferring wafers to shipping containers,

horizontally transferring wafers in the cassette to she shipping containers by means of a transfer arm mechanism and removing and transferring wafers from cassettes by means of a vacuum suction mechanism attached to sack transfer arm mechanism and

transferring and discharging the wafer to a container located at a container station and feeding interleafs in timed relation to the wafer feed so that an interleaf is positioned between each wafer loaded in a container.

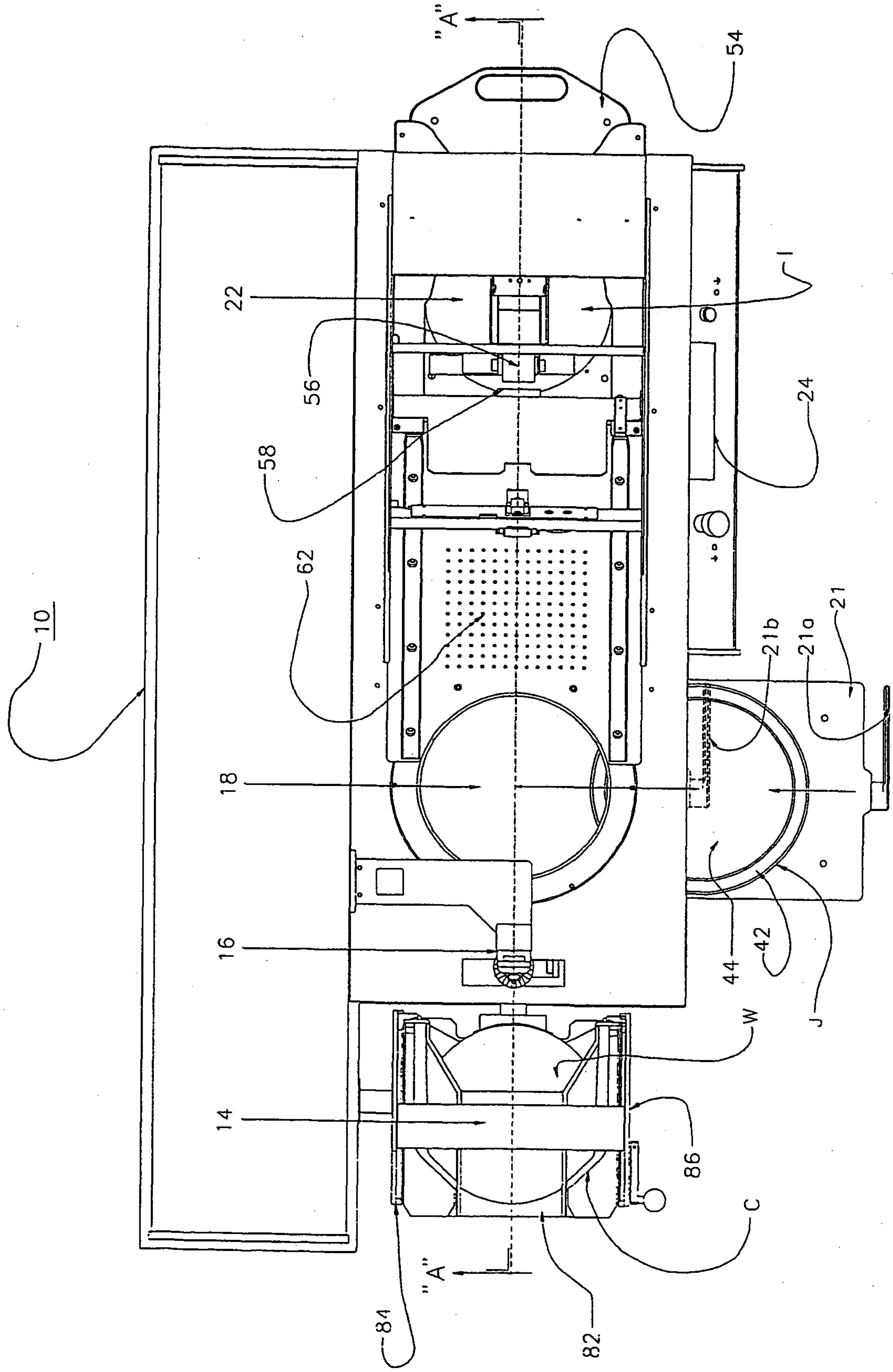



Fig 1

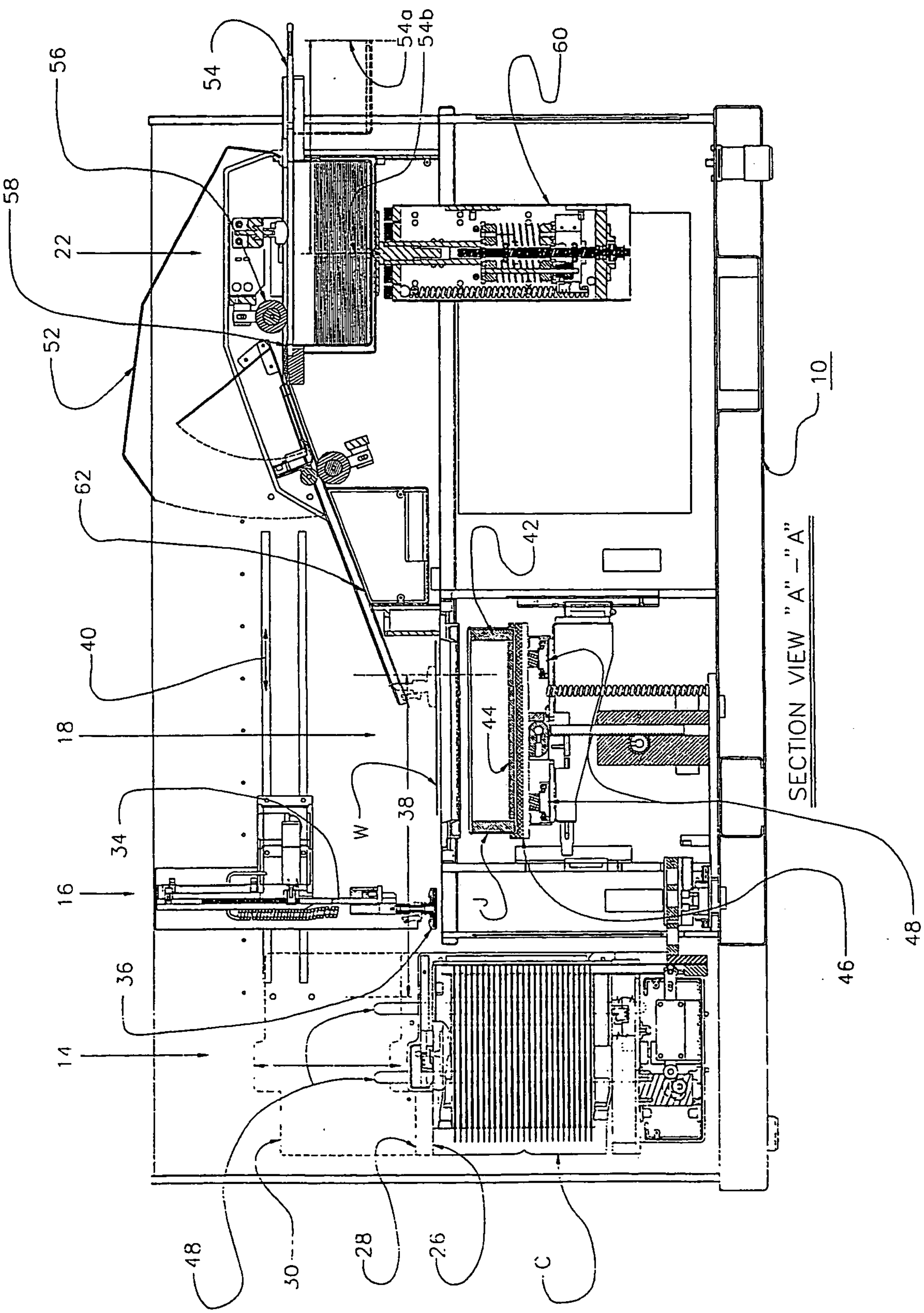

SECTION VIEW "A"–"A"
10
14
16
18
22
26
28
30
34
36
38
40
42
44
46
48
52
54
54a
54b
56
58
60
62
C
J
W

Fig 2

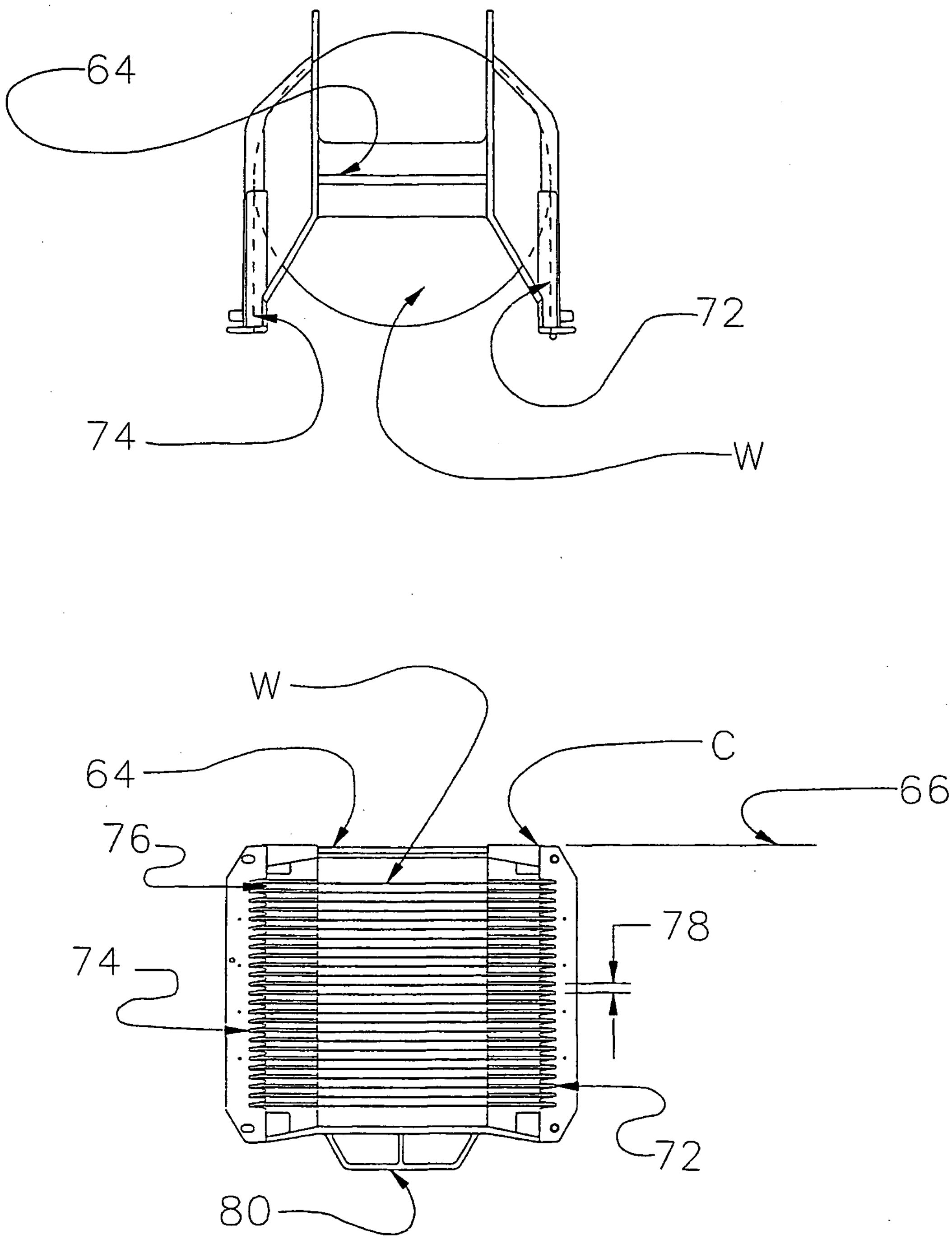



Fig 3

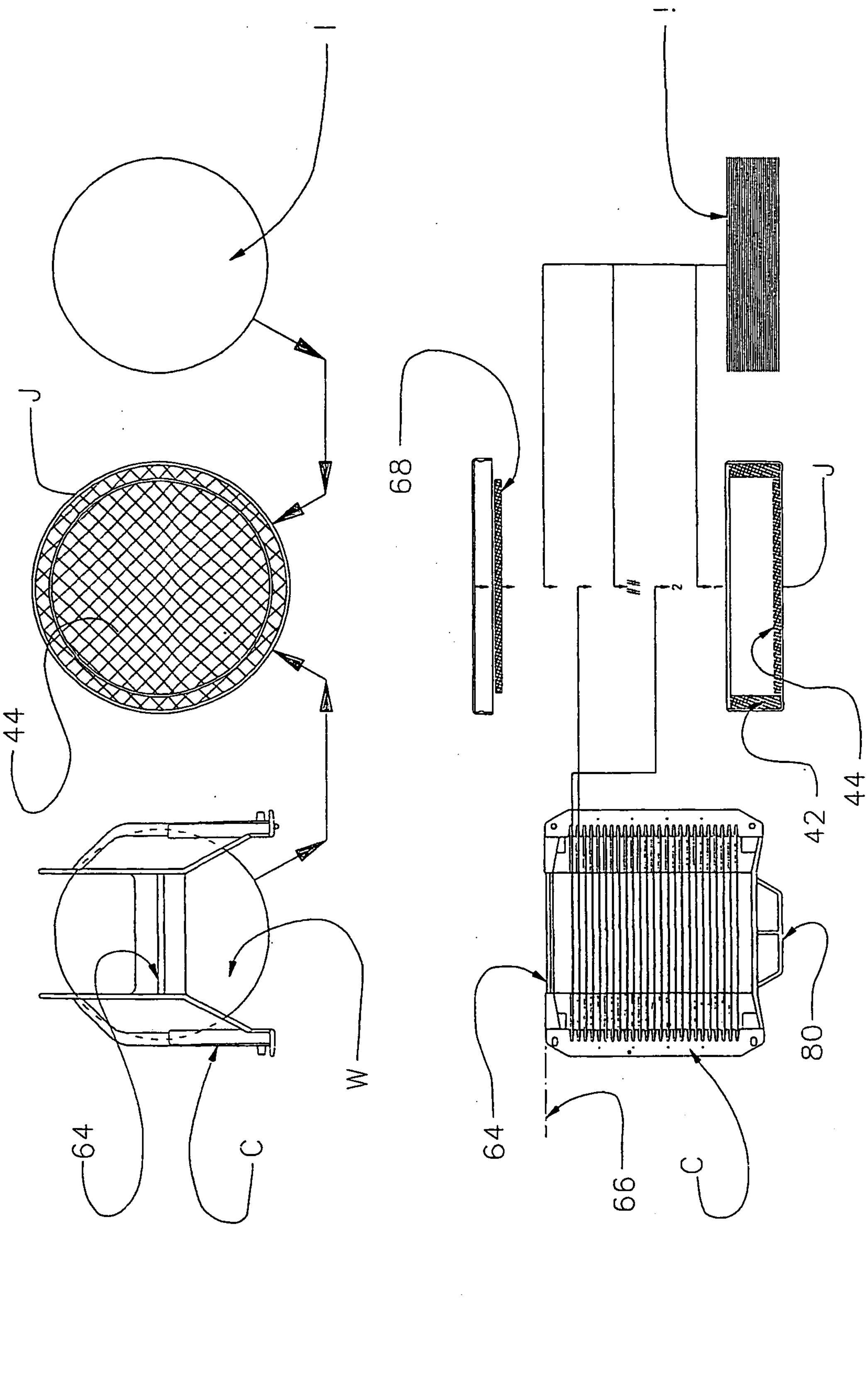



Fig 4

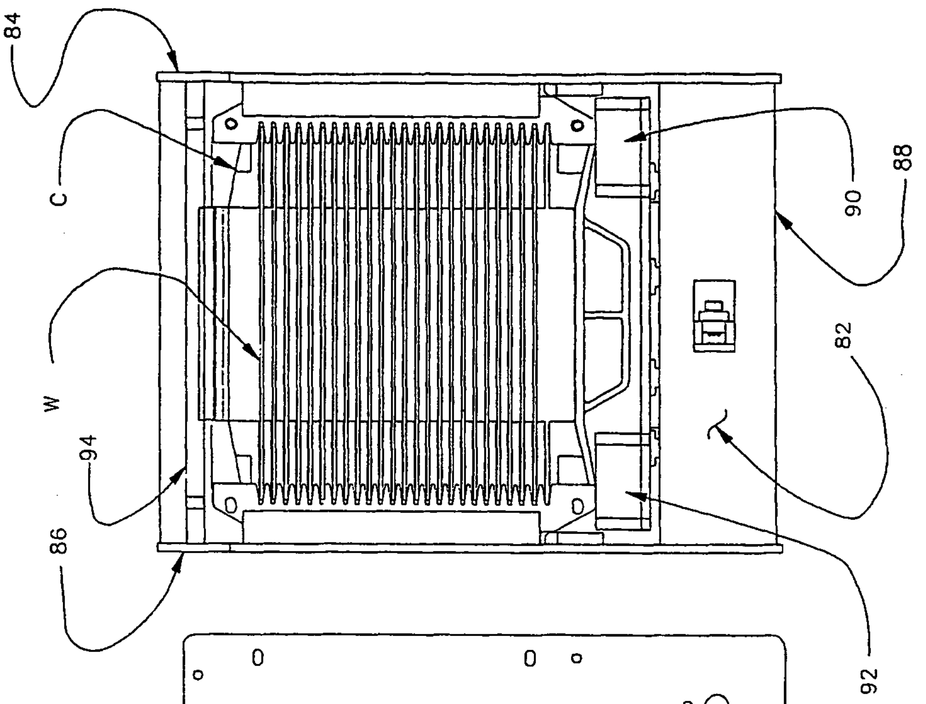



Fig. 5B

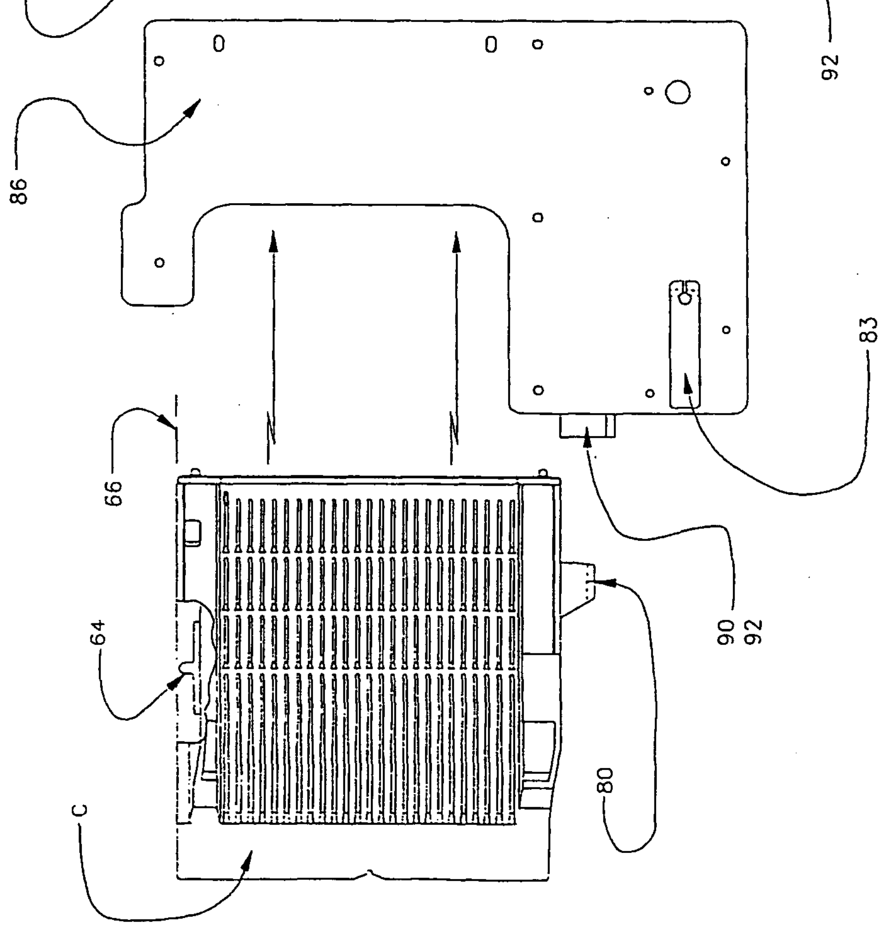



Fig. 5A

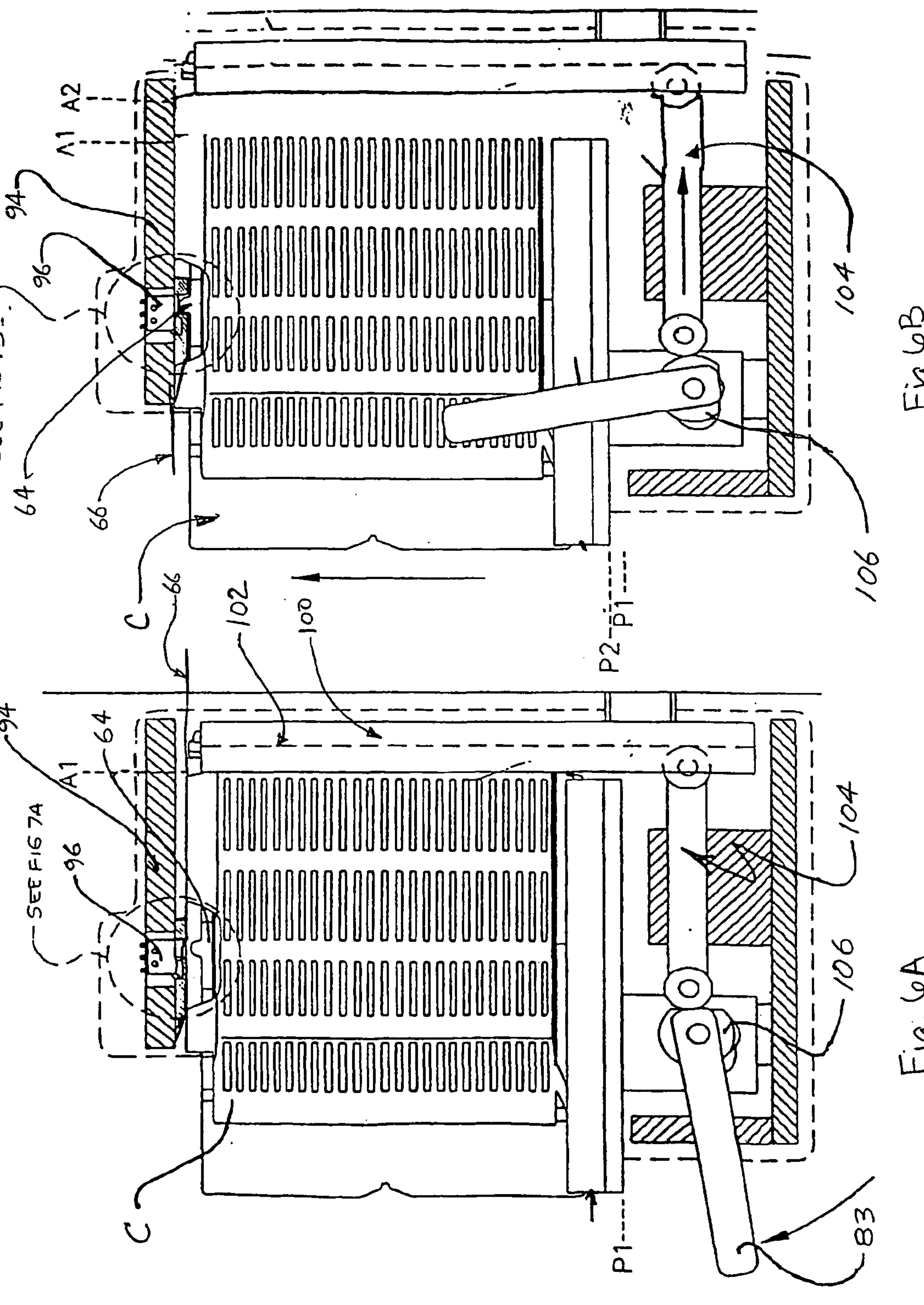



Fig 6A

Fig 6B

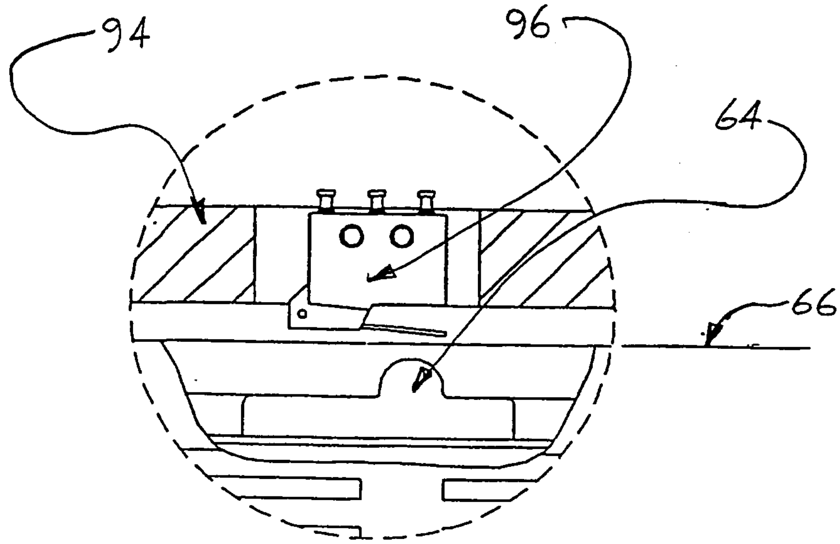



Fig- 7A

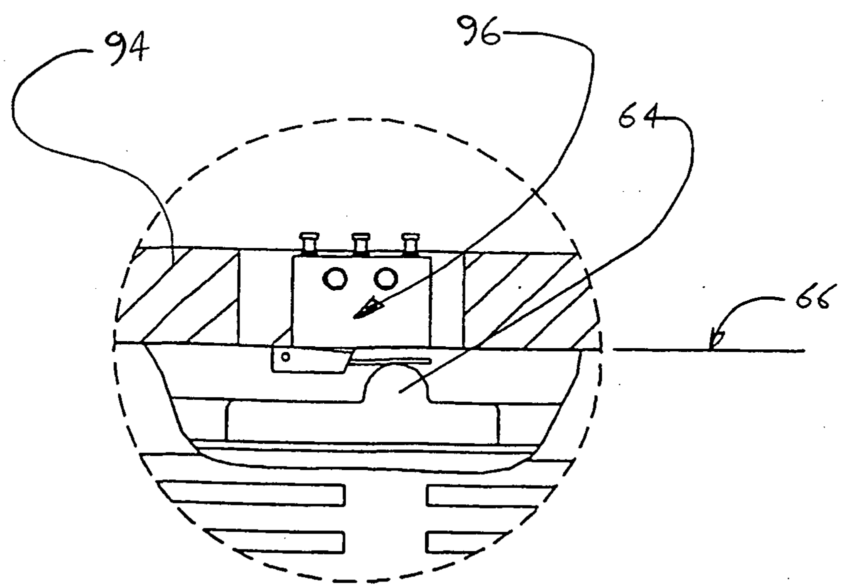



Fig- 7B

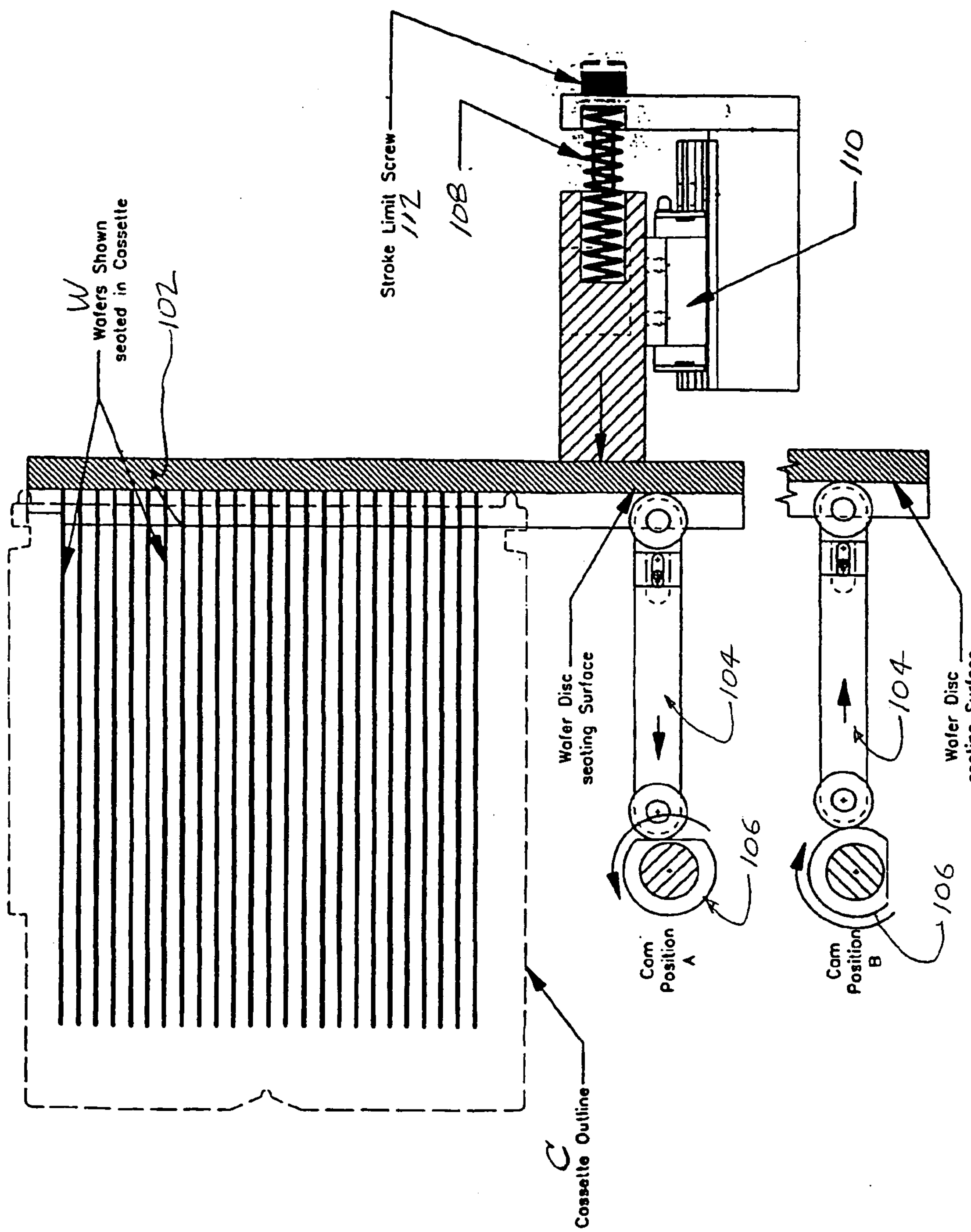

Stroke Limit Screw
112
108
110
W
Wafers Shown
seated in Cassette
102
Wafer Disc
seating Surface
104
106
Cam
Position
A
104
Wafer Disc
seating Surface
106
Cam
Position
B
C
Cassette Outline

Fig 8

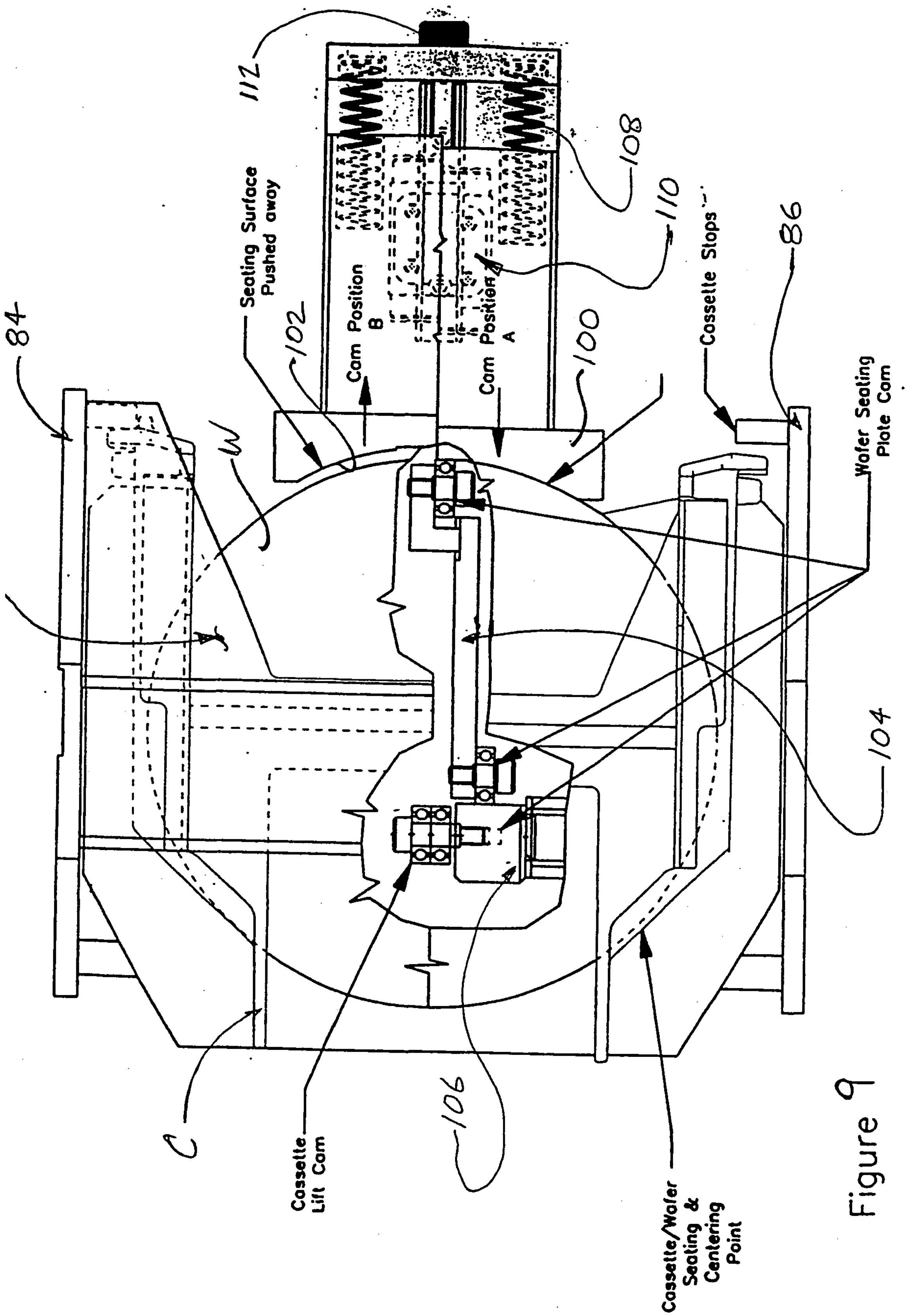

112
108
110
86
84
Seating Surface Pushed away
102
Cam Position B
Cam Position A
100
Cassette Stops
Wafer Seating Plate Cam
W
104
C
106
Cassette Lift Cam
Cassette/Wafer Seating & Centering Point

Figure 9

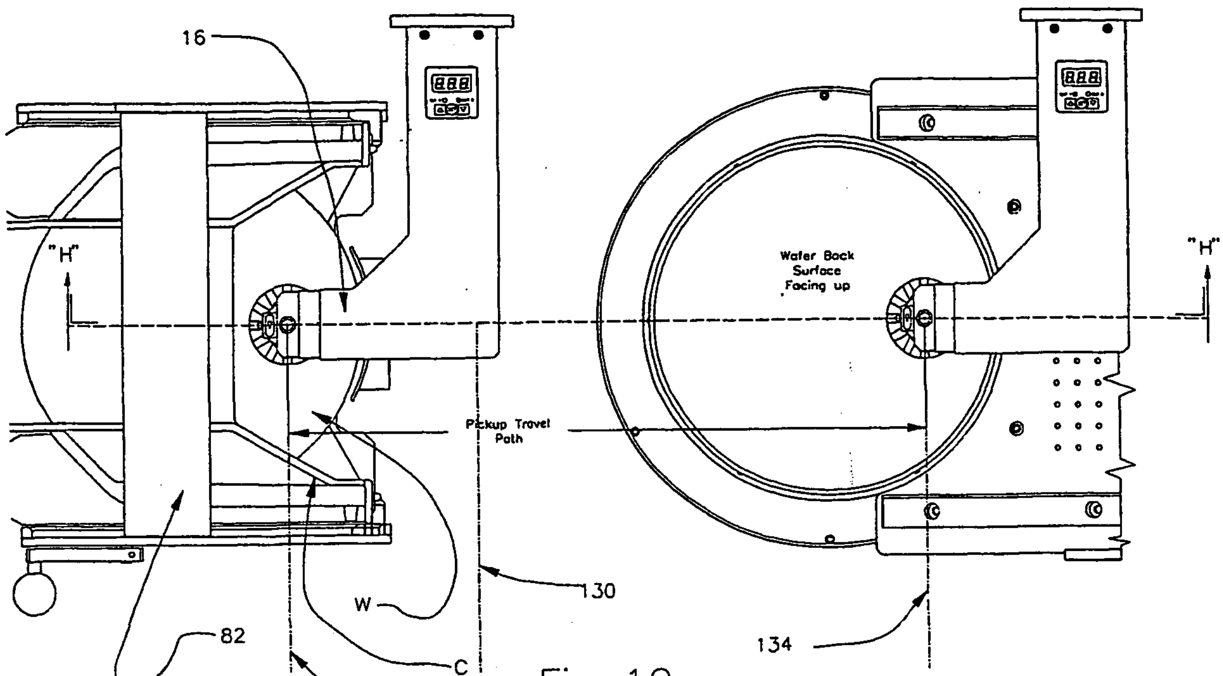
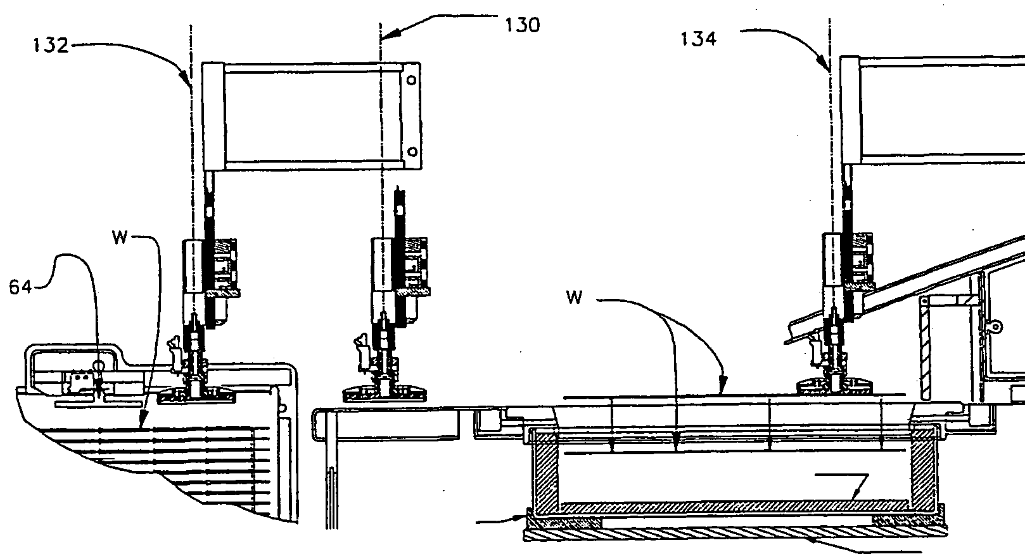



Fig 10




SECTION VIEW "H" – "H"

Fig 11

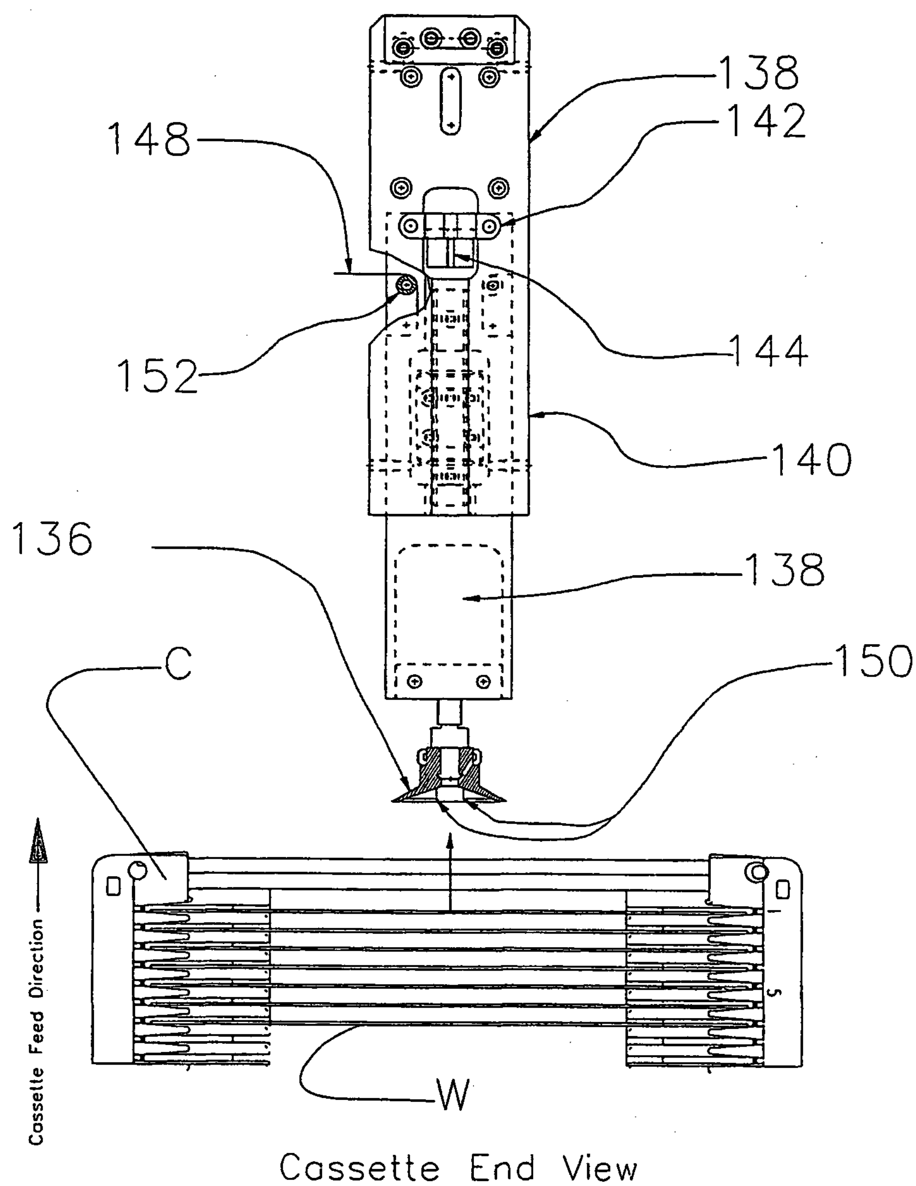

138
142
148
144
152
140
136
138
C
150
Cassette Feed Direction
W
Cassette End View

Fig 12

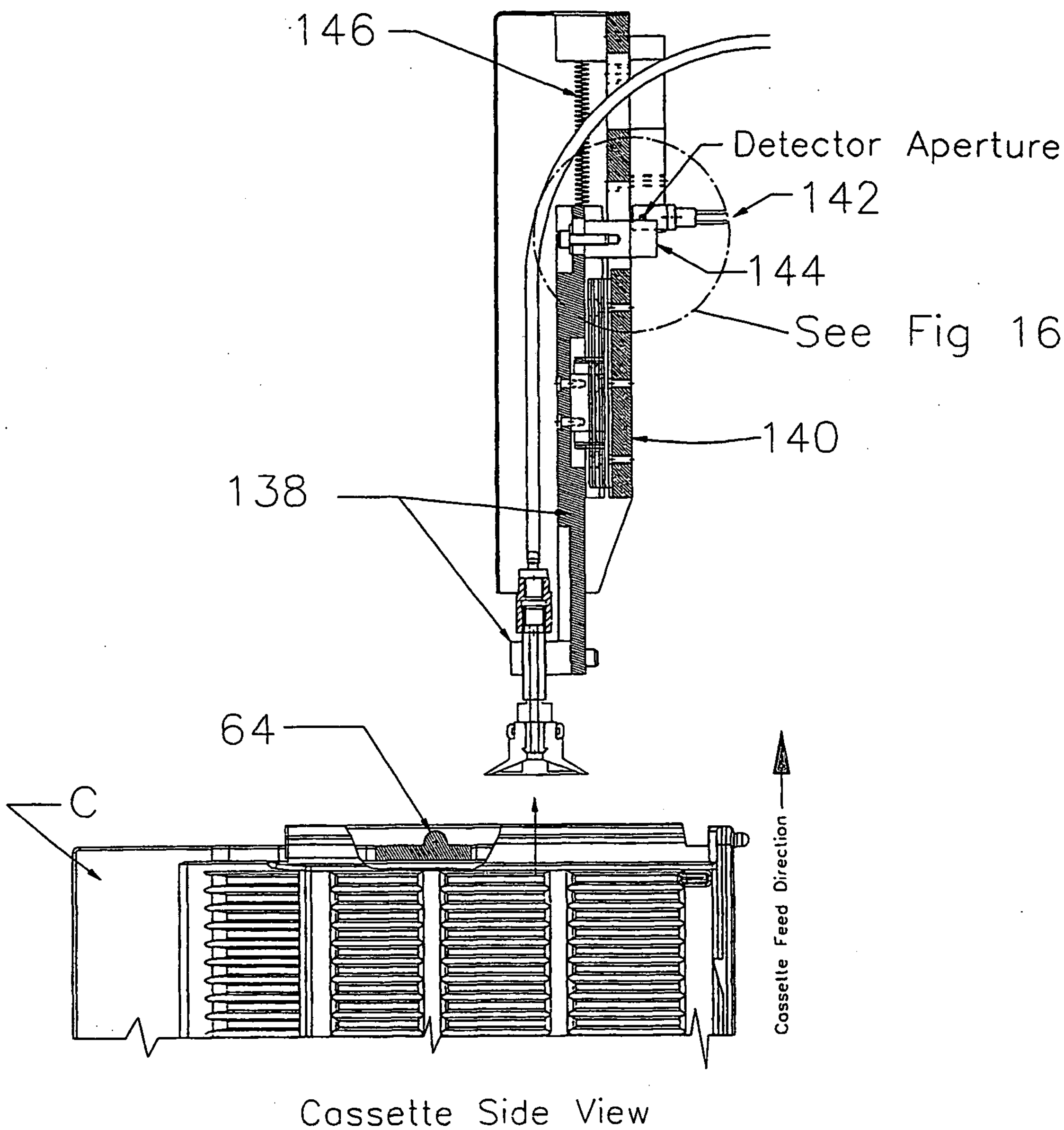

146
Detector Aperture
142
144
See Fig 16
140
138
64
C
Cassette Feed Direction
Cassette Side View

Fig 13

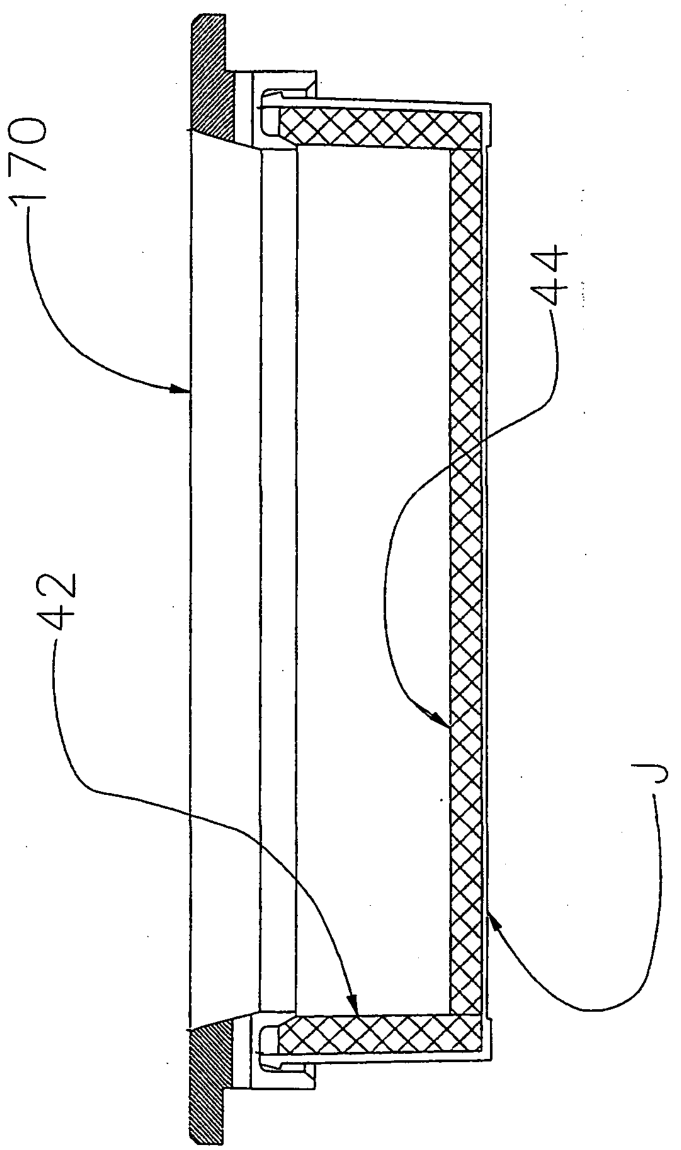



Fig 14

Fig 15

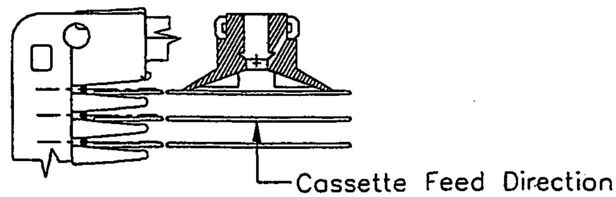



Fig 16

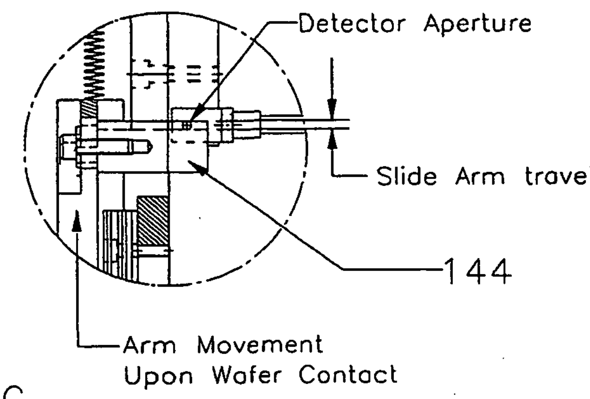
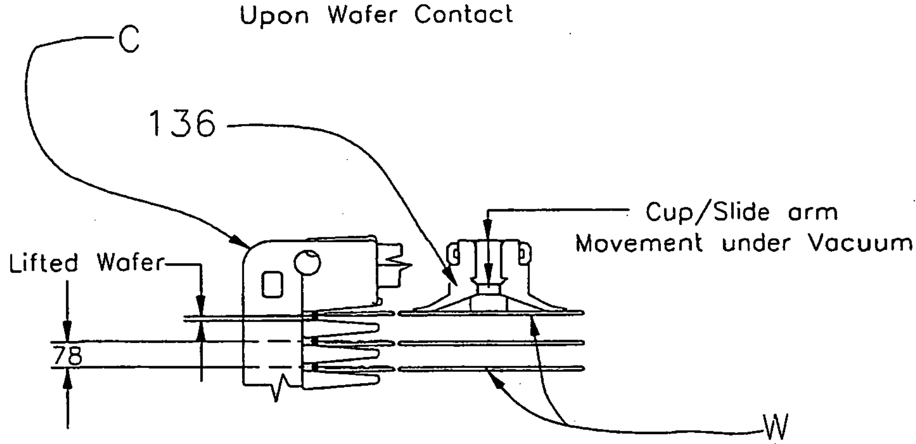



Fig 17



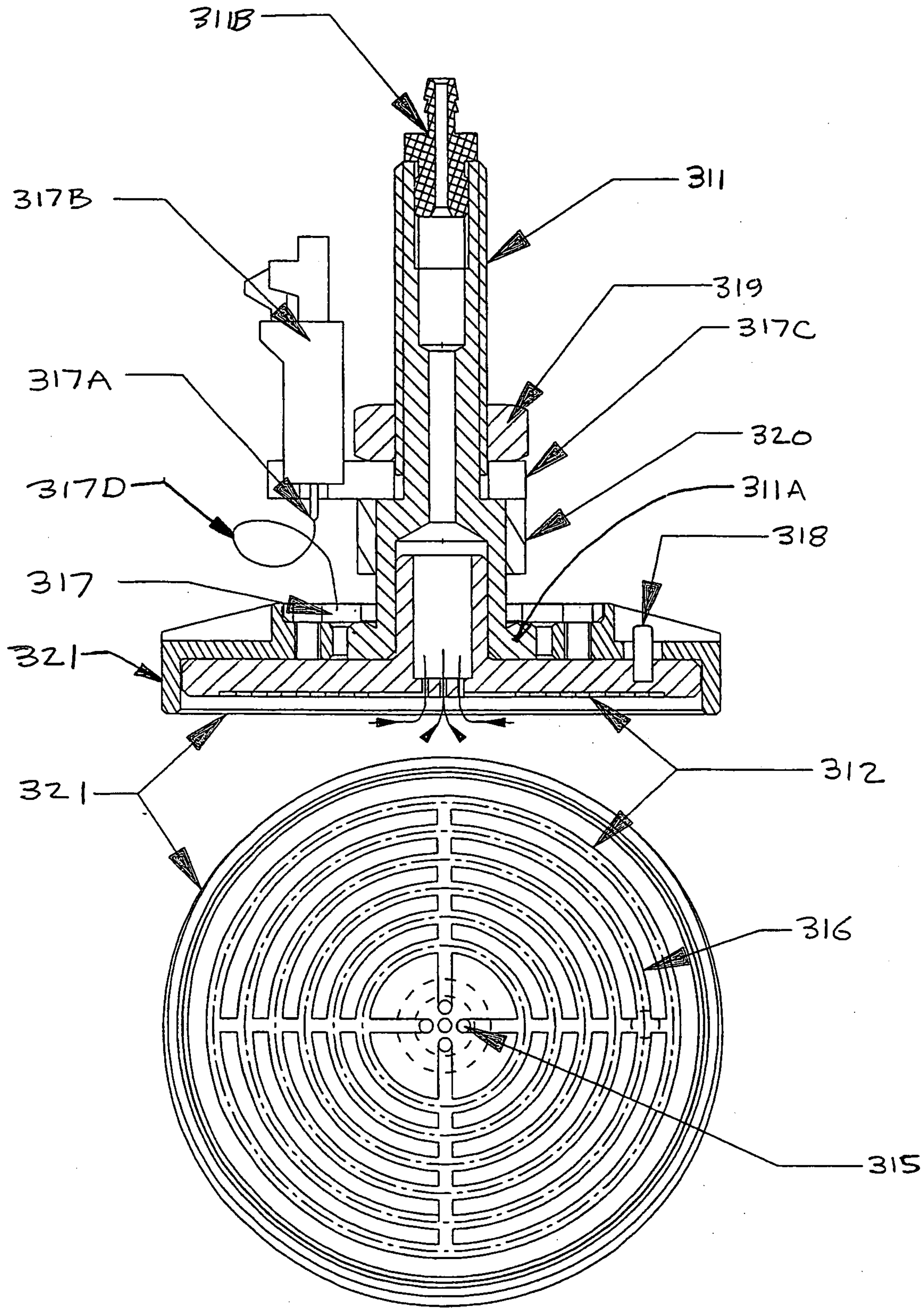

311B
311
317B
319
317C
317A
320
317D
311A
318
317
321
321
312
316
315

Fig 18

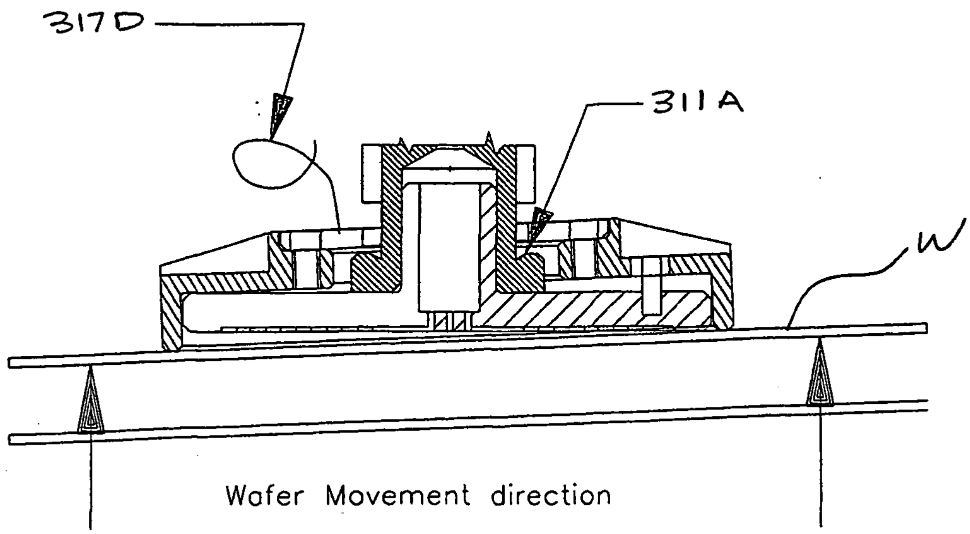

317D
311A
W
Wafer Movement direction

Fig 19

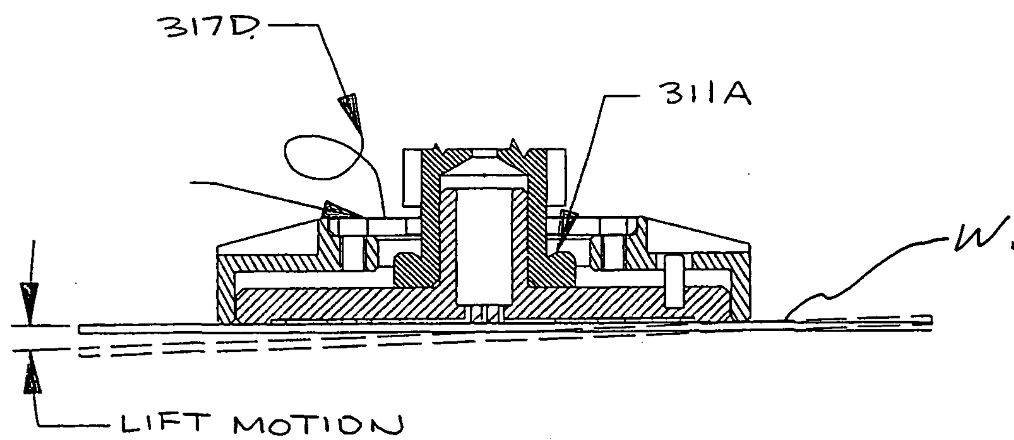

317D
311A
W.
LIFT MOTION

Fig 20

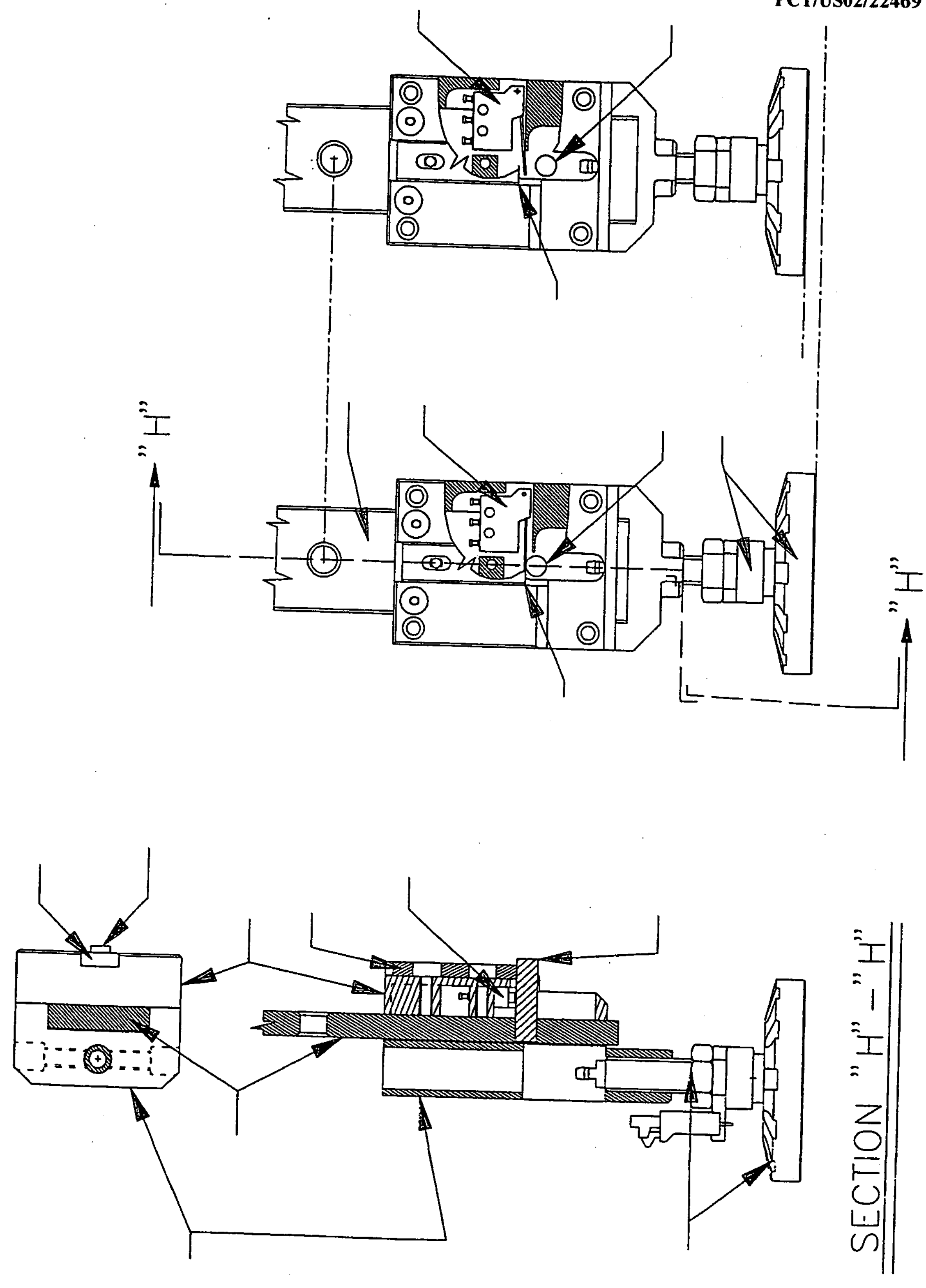



Fig 21

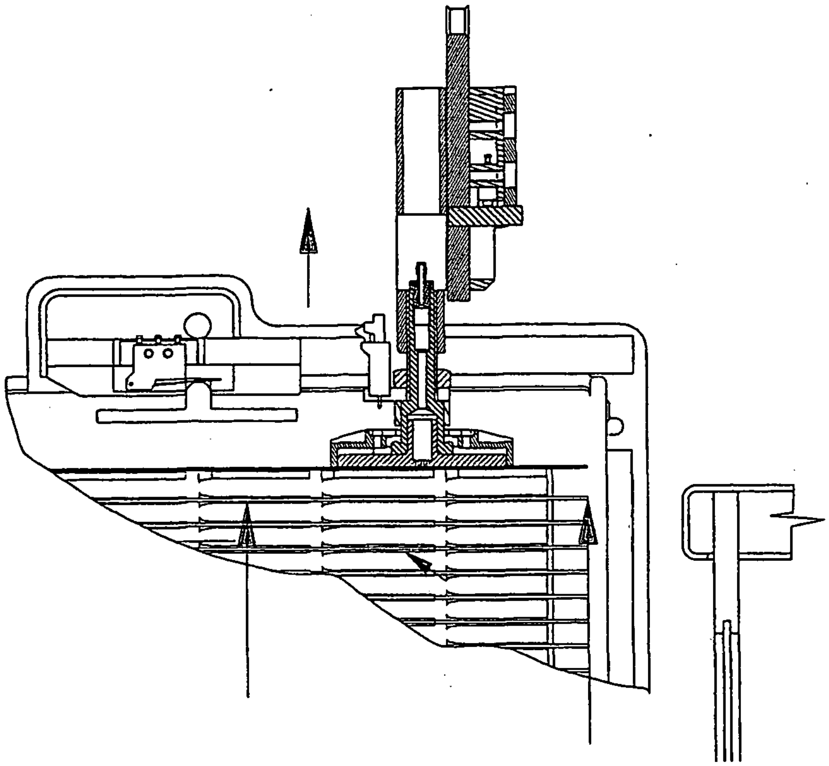


Fig 22

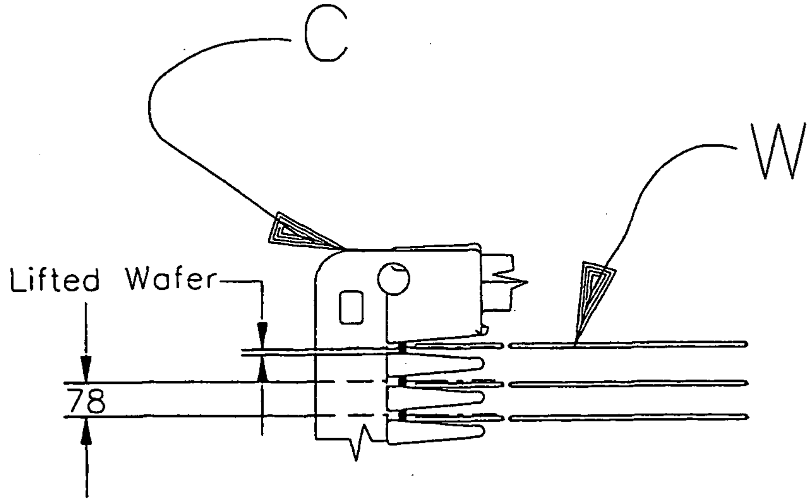



Fig 23

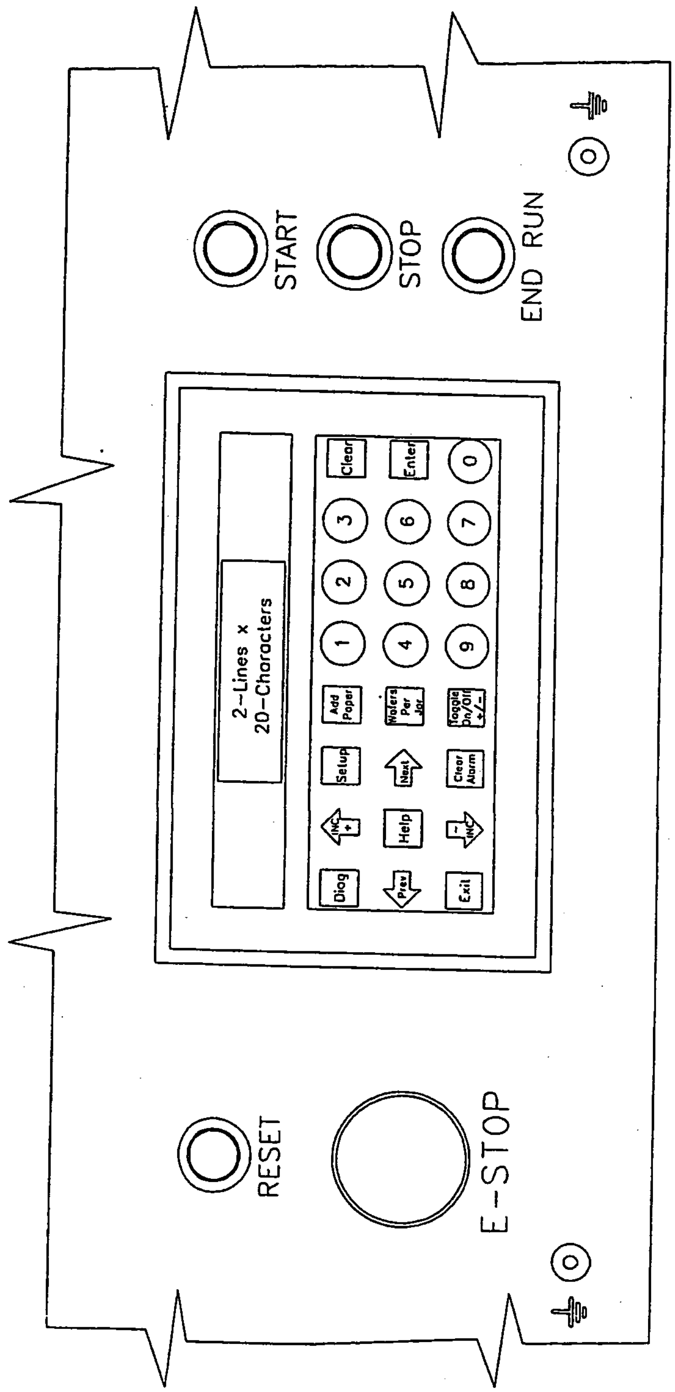

START
STOP
END RUN
2-Lines x
20-Characters
Clear
Enter
0
1
2
3
4
5
6
7
8
9
Add Paper
Wafers Per Jar
Toggle On/Off +/-
Setup
Next
Clear Alarm
INC +
Help
- INC
Diag
Prev
Exit
RESET
E-STOP

Fig 24

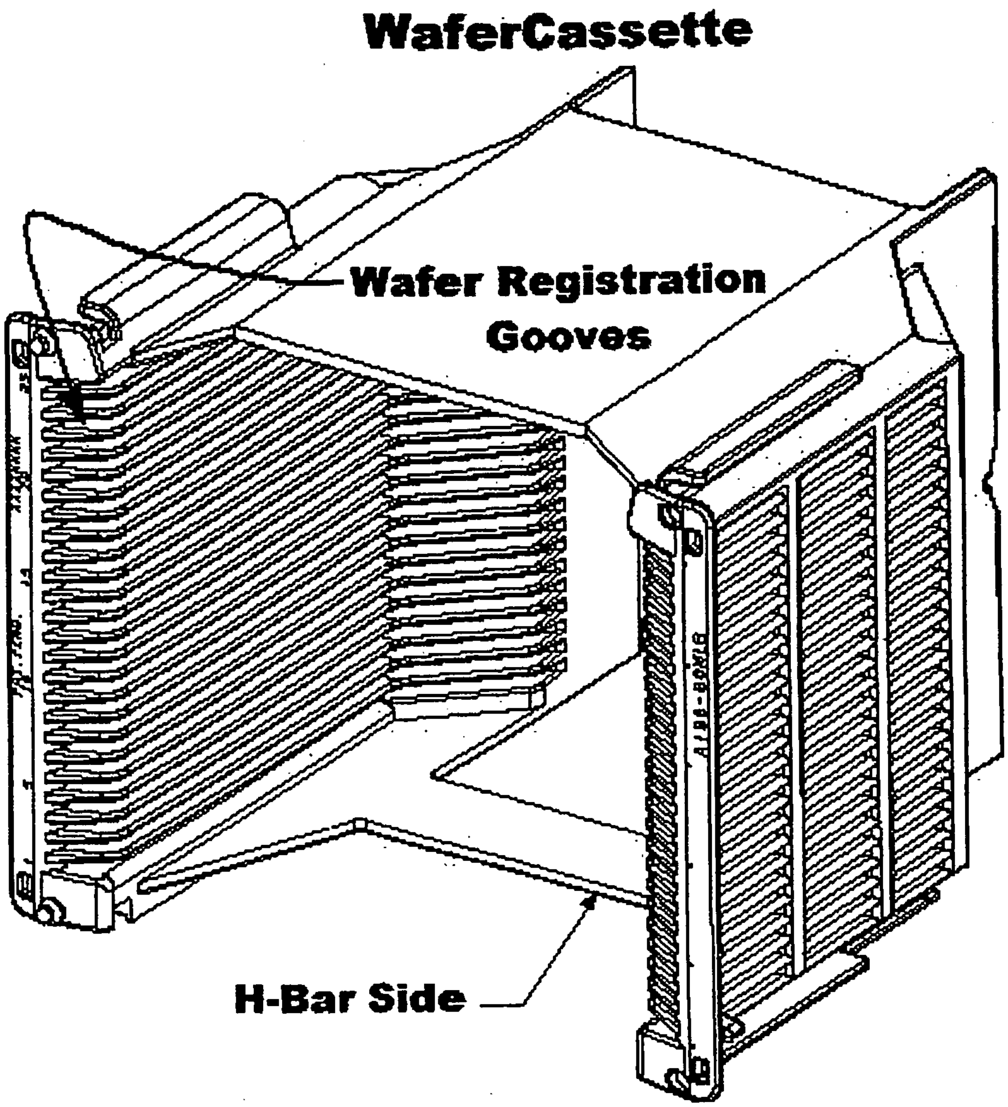



Fig 25

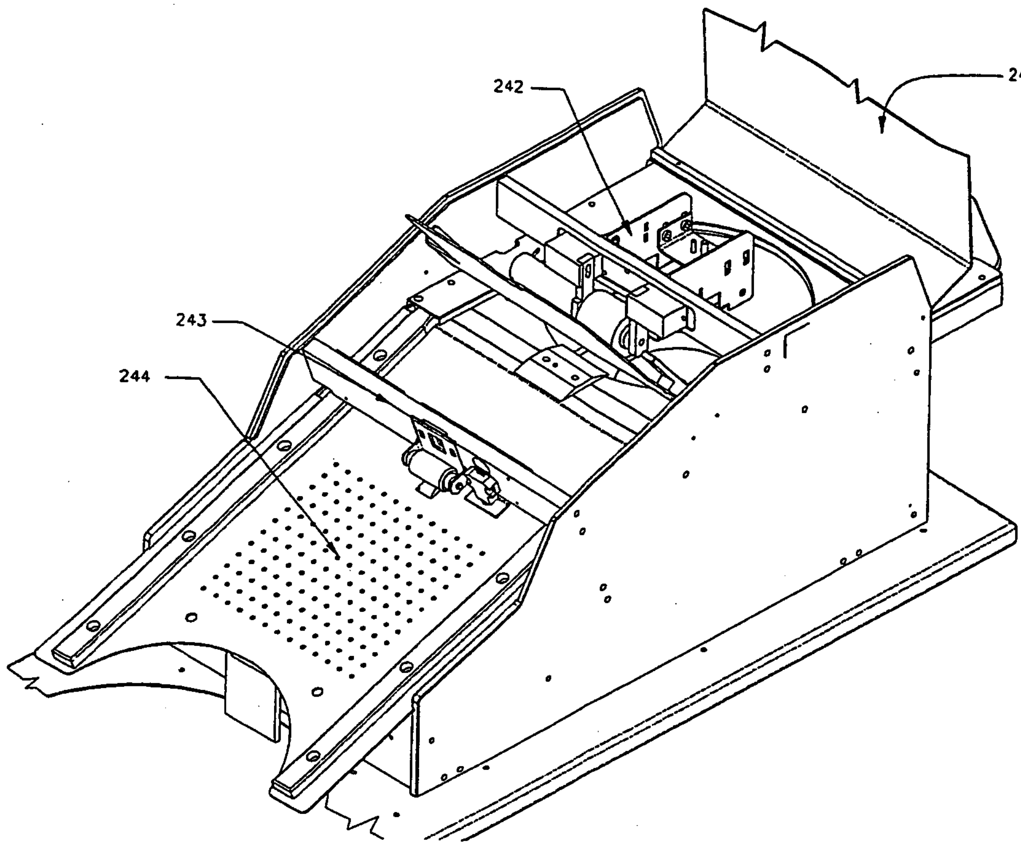



Fig 26

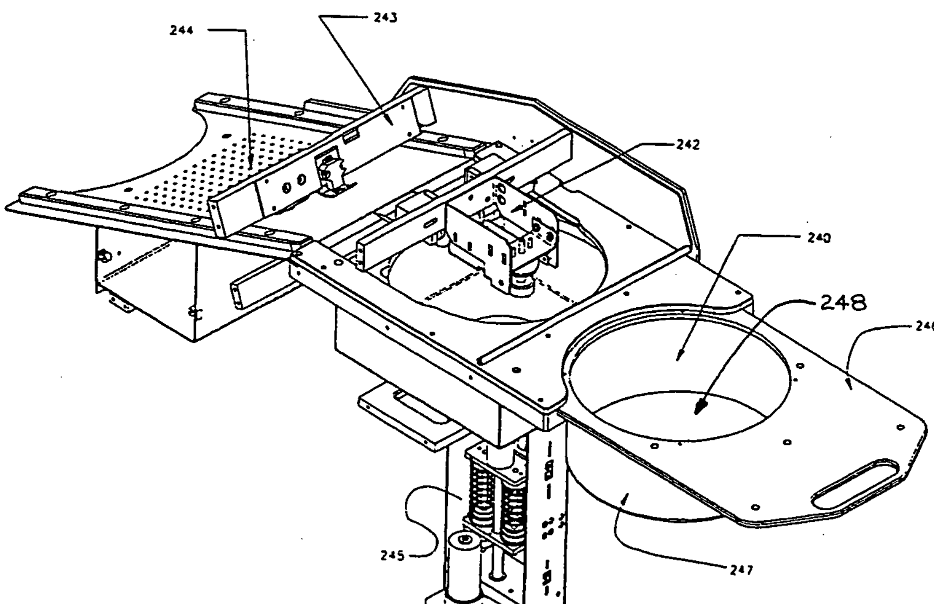



Fig 27

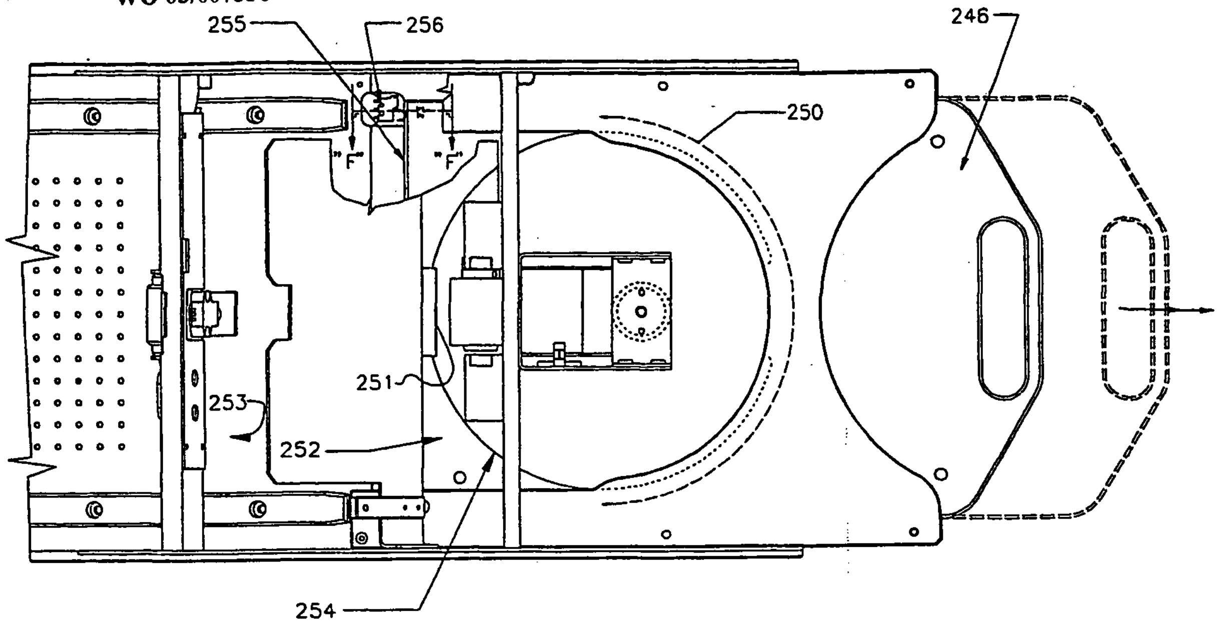



Fig 28

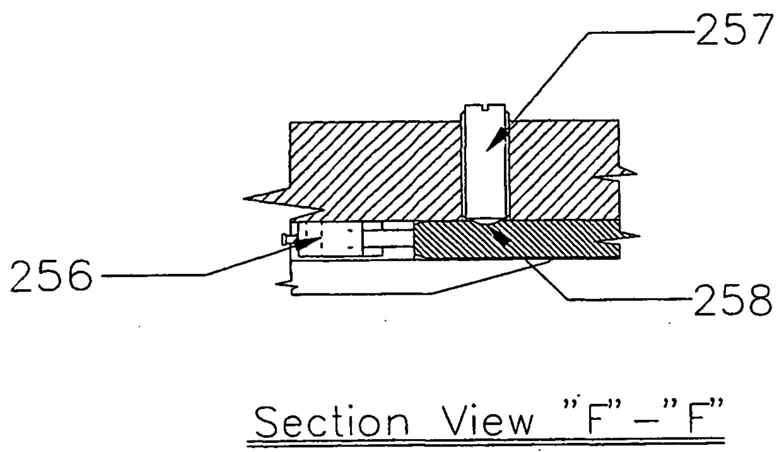



Fig 29

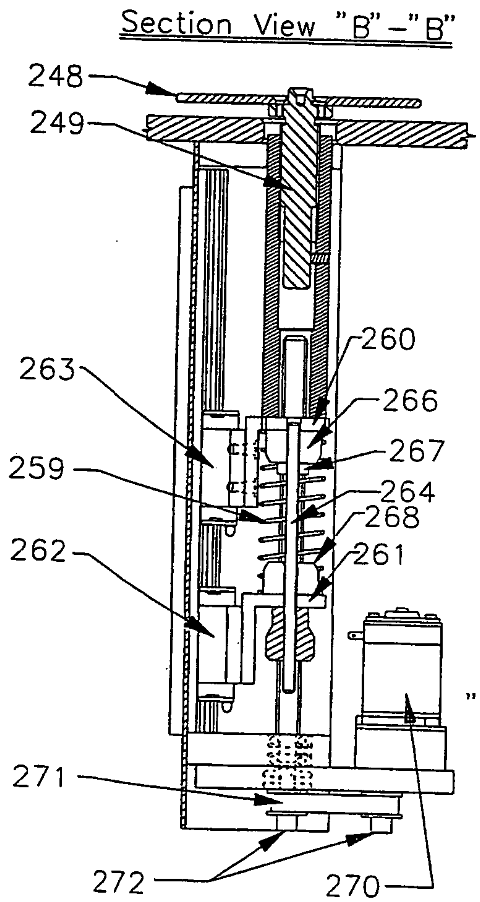



Fig 30

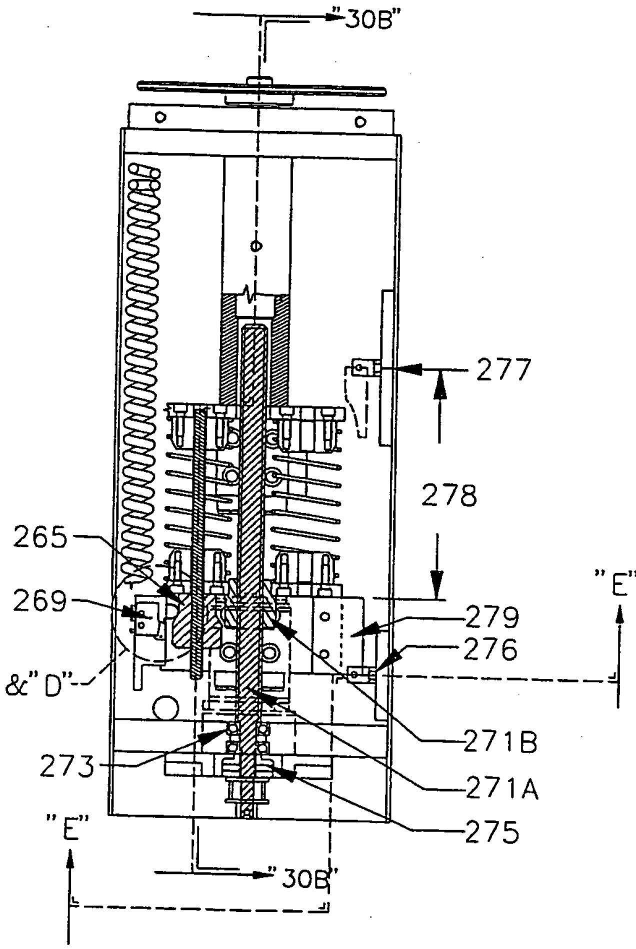



Fig 30A

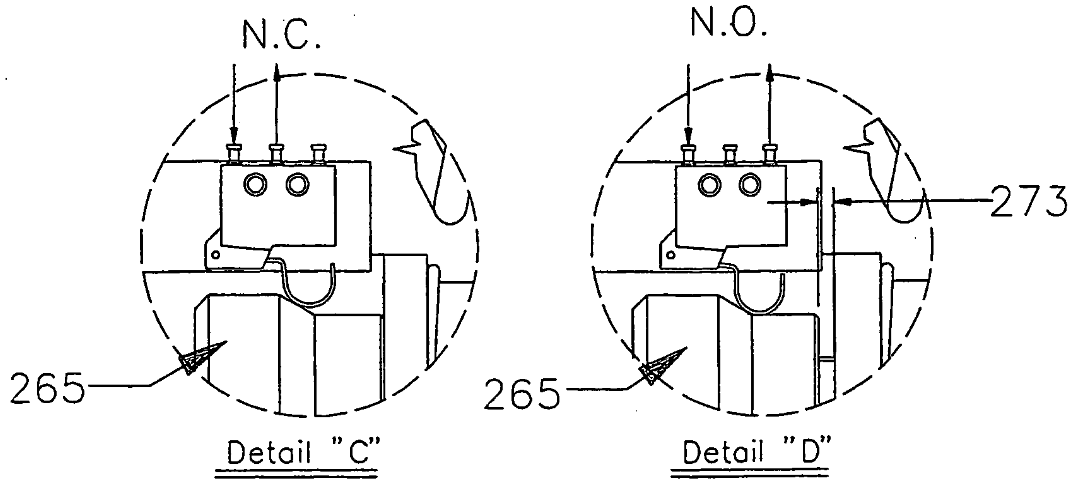



Fig 31

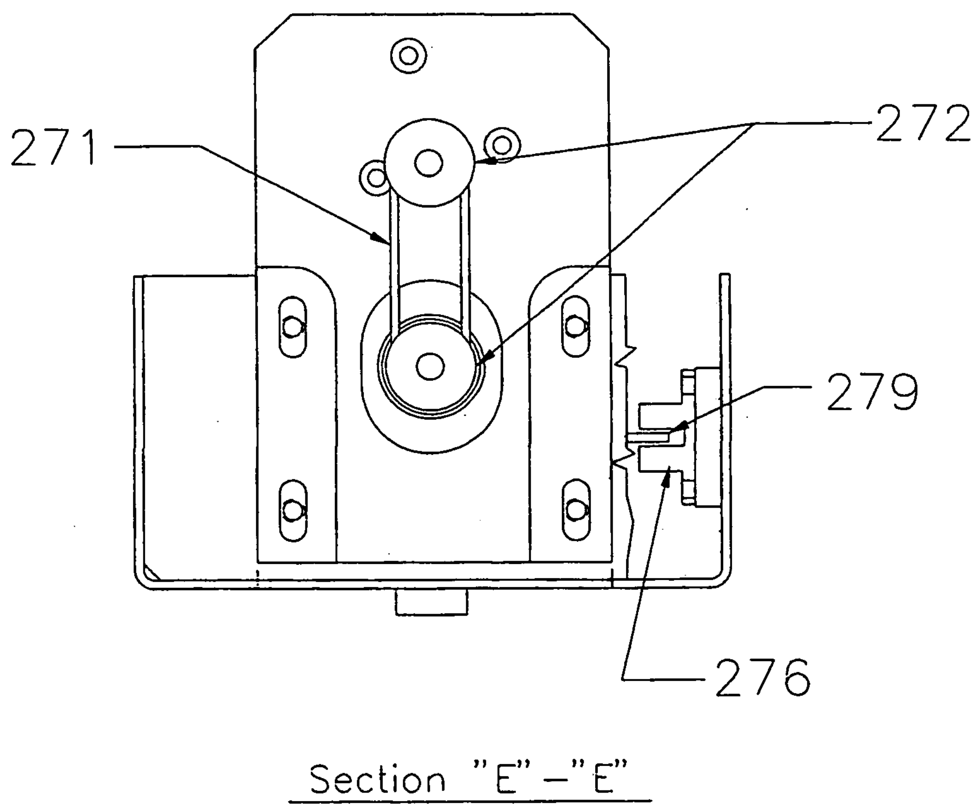



Fig 32

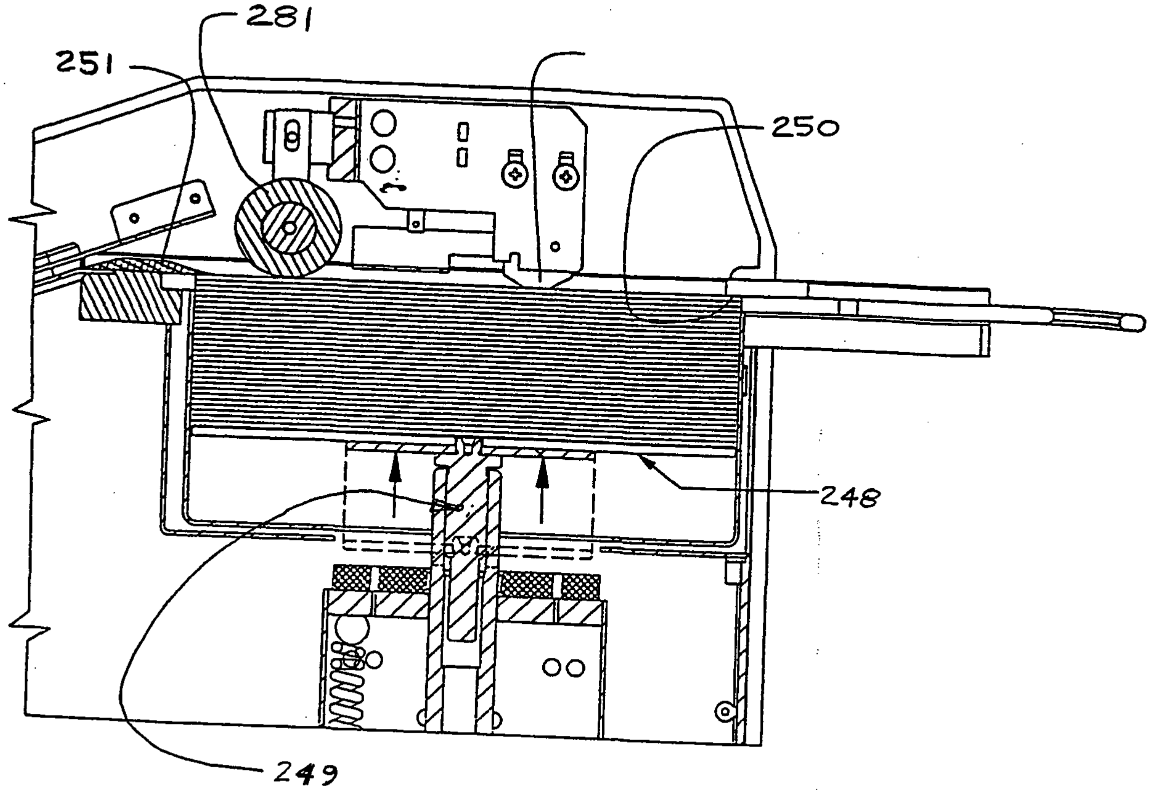



Fig 33

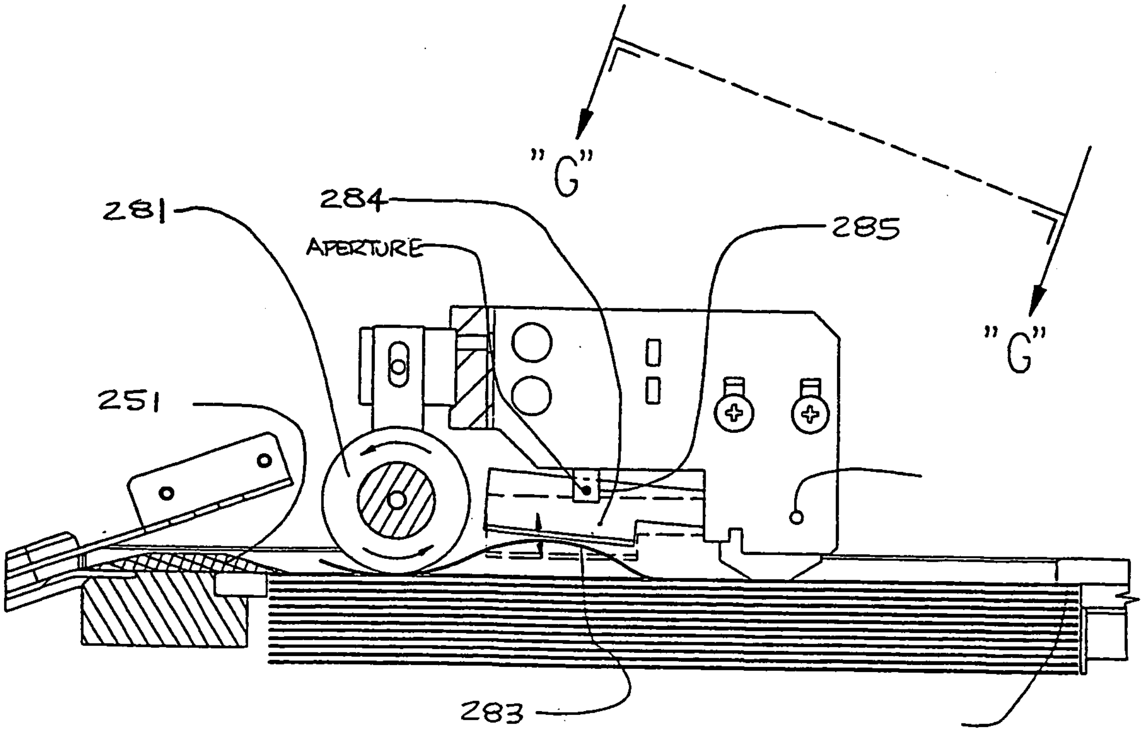



Fig 34

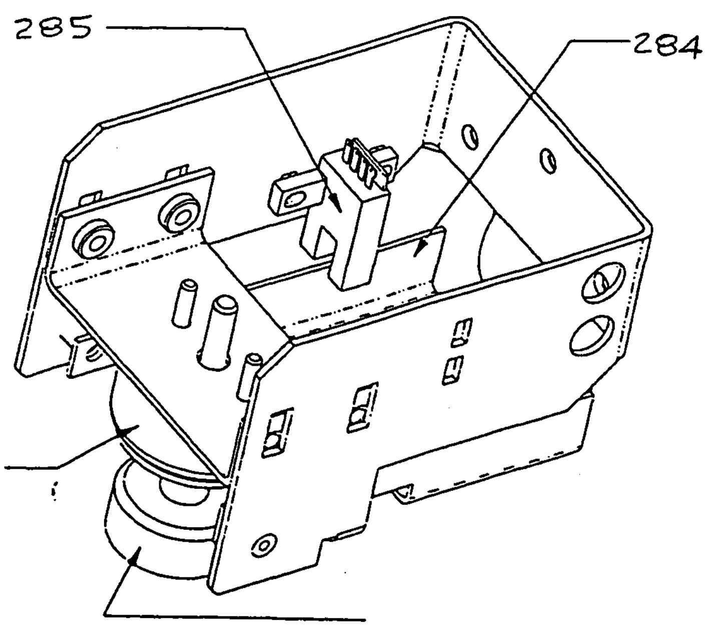



Fig 35

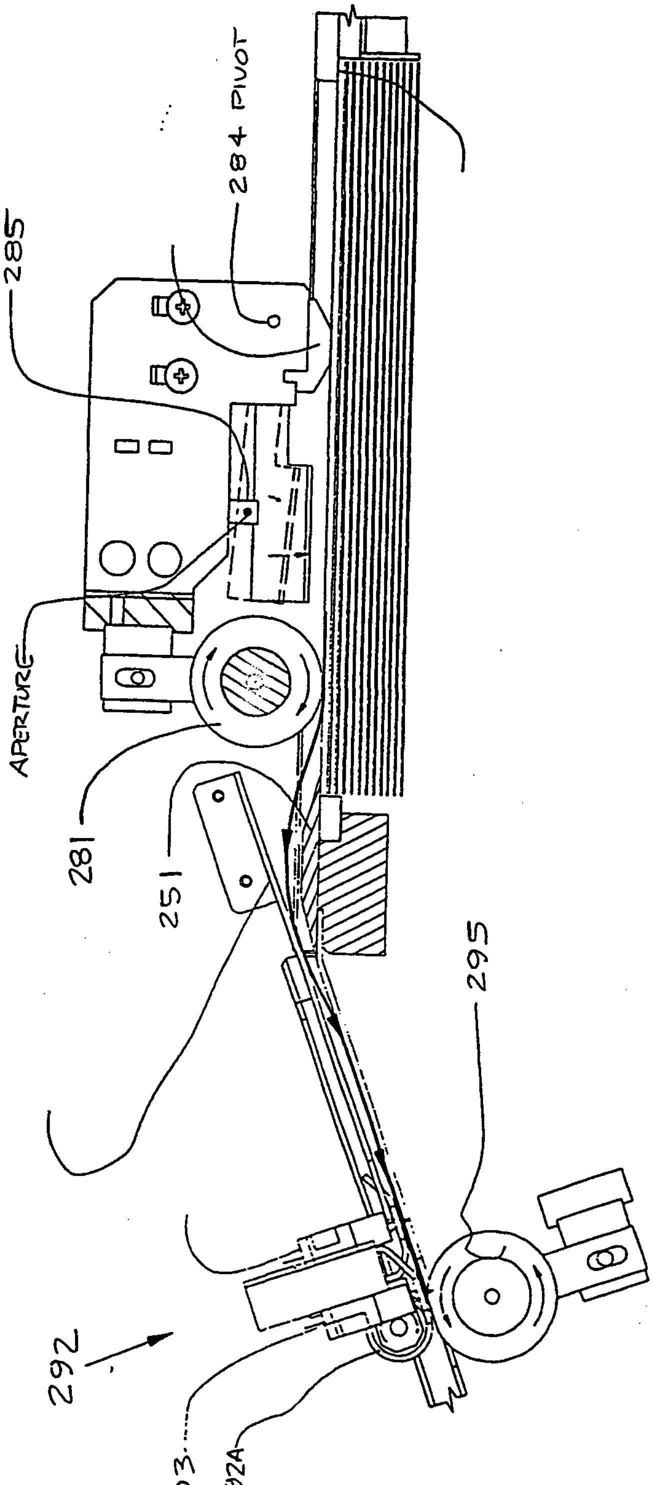



Fig 36

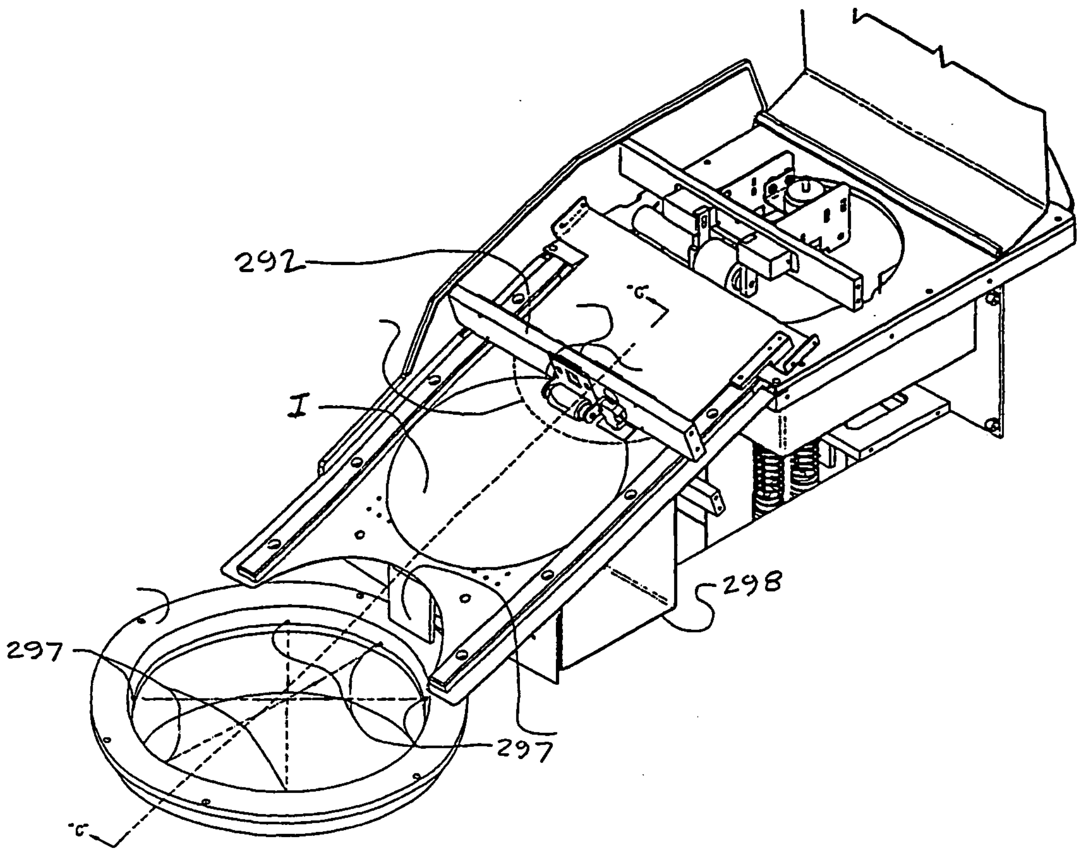



Fig 37

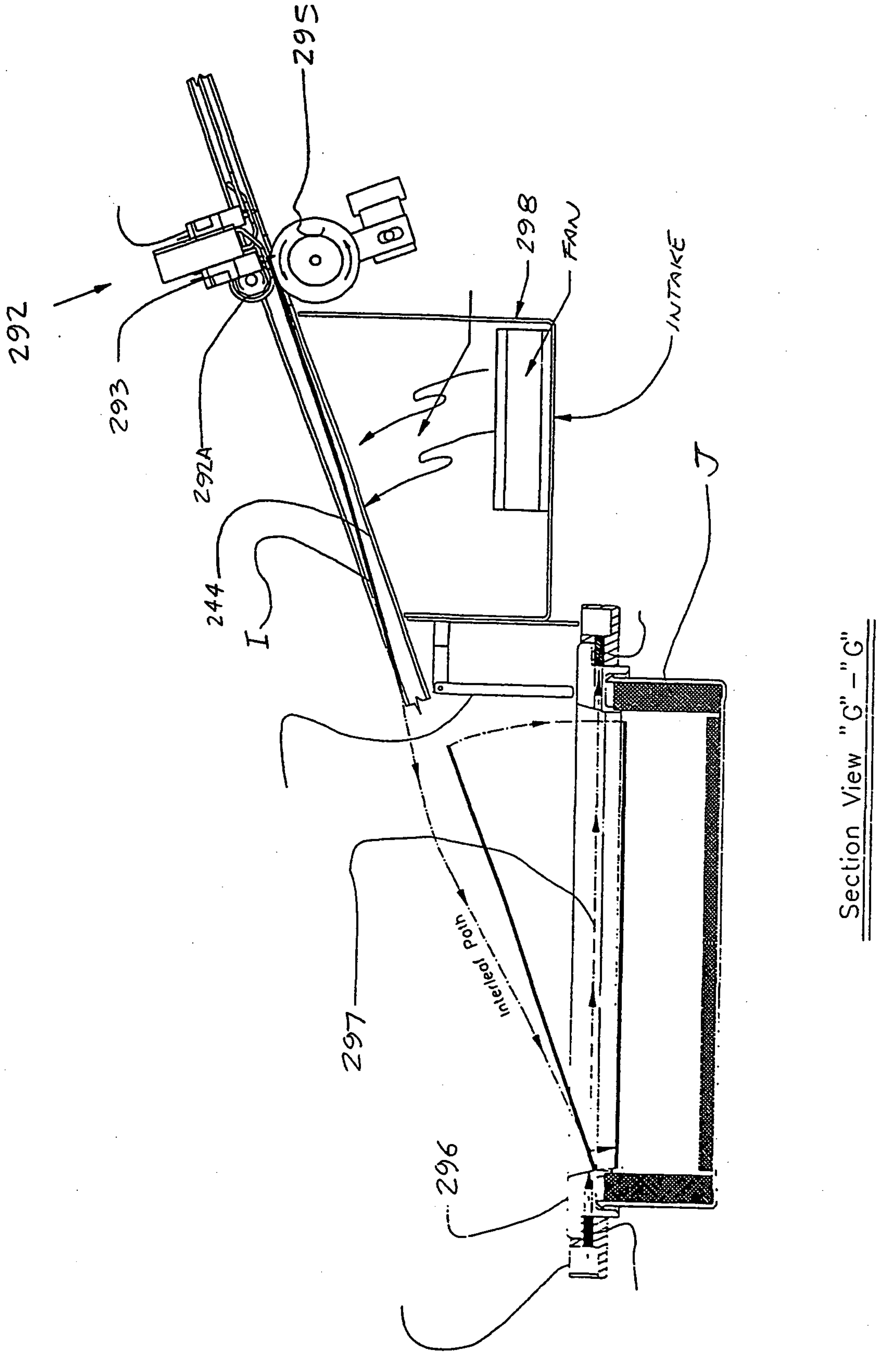

292
293
292A
295
298
FAN
INTAKE
J
244
I
297
Interleaf Path
296
Section View "G"-"G"

Fig. 38

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 January 2003 (23.01.2003)

PCT

(10) International Publication Number
**WO 03/007350 A3**

(51) International Patent Classification⁷: **H01L 21/00**

(21) International Application Number: PCT/US02/22469

(22) International Filing Date: 11 July 2002 (11.07.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/304,904 12 July 2001 (12.07.2001) US

(71) Applicant: **SPEEDLINE MANUFACTURING COMPANY** [US/US]; 1820 Springvalley Drive, Springfield, PA 19064 (US).

(71) Applicants and
(72) Inventors: **LINKER, Frank, V, II** [US/US]; 1820 Springvalley Drive, Springfield, PA 19064 (US). **LINKER, Frank, V, Jr.** [US/US]; 242 Sussex Boulevard, Broomall, PA 19008 (US).

(74) Agent: **RENZ, Eugene, E., Jr.**; Eugene E. Renz, Jr., P.C., 205 North Monroe Street, P.O. Box 2056, Media, PA 19063-9056 (US).

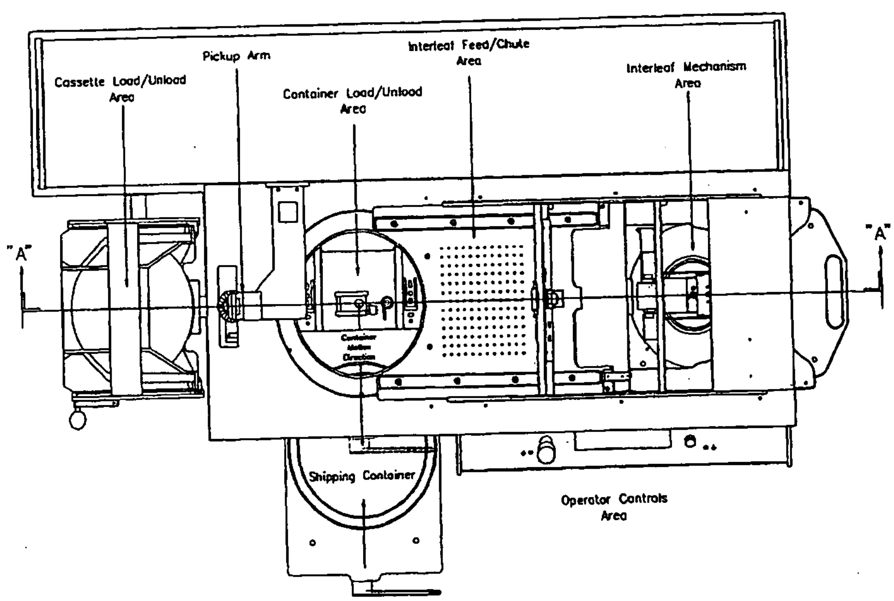
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *with international search report*

*[Continued on next page]*

(54) Title: WAFER JAR LOADER METHOD, SYSTEM AND APPARATUS




(57) **Abstract:** A method for packaging wafers having a bottom side and a top circuit side in jars comprising the steps of placing a cassette (c) having a plurality of pockets for wafers at the back side facing upward, transferring the top wafer (w) in the cassette by means of a vacuum suction mechanism which centers the top wafer in the cassette pocket upon initial engagement and then transfers and discharges the wafer in a jar (j) located at a jar station and feeding interleaf in timed relation to the wafer feed so that an interleaf is positioned between each wafer loaded in a jar.

WO 03/007350 A3

(88) Date of publication of the international search report: 24 July 2003

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/22469

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) :H01L 21/00
US CL :414/797; 438/716
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 414/789.5, 796.5, 797; 438/106, 107, 716

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 4,336,438 A (UEHARA et al) 22 June 1982 (22/06/82), see enture docunent. | 1-12 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 06 NOVEMBER 2002 | 19 DEC 2002 |
| Name and mailing address of the ISA/US<br>Commissioner of Patents and Trademarks<br>Box PCT<br>Washington, D.C. 20231<br>Facsimile No. (703) 305-3230 | Authorized officer<br>WILLIAM A. POWELL<br>Jean Proctor<br>Paralegal Specialist<br>Telephone No. (703) 308-1975 |

THIS PAGE BLANK (USPTO)